SCIENCE

VOL. 74 FRIDAY, NOVEMBER 13, 1931 No. 1924

The United States Army Medical Department and its Relation to Public Health: MAJOR EDGAR ERSKINE HUME 465

Obituary:
Richard Alexander Fullerton Penrose, Jr.: DR. JOSEPH STANLEY-BROWN. *Recent Deaths* 476

Scientific Events:
The Bermuda Fresh-water System; Topographical Maps; The Agricultural Experiment Stations; A New Harvard Observatory; A Junior Nobel Award 478

Scientific Notes and News 481

Discussion:
Concerning an Increase in the Potency of Mosaic Virus in Vitro: DR. PETER K. OLITSKY and DR. FILIP C. FORSBECK. *Geomorphological Evidence of a Climatic Boundary:* PROFESSOR RICHARD JOEL RUSSELL. *Chlorates as Herbicides:* DR. W. E. LOOMIS, RUSSELL BISSEY and E. V. SMITH. *The Causative Organism of a Papular Type of Apple Measles:* PROFESSOR ANTHONY BERG. *Biological Abstracts:* DR. PAUL D. LAMSON 483

Scientific Apparatus and Laboratory Methods:
An Adaptation of the Box Camera to Photomicrography: DR. CHARLES S. APGAR. *A Method for the Preservation of Old Manuscripts:* J. P. SANDERS and DR. F. K. CAMERON. *The Use of Live Nemas (Metoncholaimus Pristiurus) in Zoological Courses in Schools and Colleges:* DR. N. A. COBB 487

Special Articles:
A Chart of Radioactive Elements Indicating their Structure: PROFESSOR INGO W. D. HACKH. *The Sugar Tolerance of Yeasts Expressed in Atmospheres:* DR. MARGARET B. CHURCH. *More Data on the Lung Fluke in North America:* DONALD J. AMEEL 490

Science News 10

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE UNITED STATES ARMY MEDICAL DEPARTMENT AND ITS RELATION TO PUBLIC HEALTH[1]

By Major EDGAR ERSKINE HUME

MEDICAL CORPS, U. S. ARMY

AN army exists for the purpose of destroying the power of the enemy and preventing his retaliating in kind. The medical department of an army is, as are all branches, charged with doing all possible to bring about this end. Specifically, in the words of our army regulations:

The mission of the Medical Department is the conservation of man power—the preservation of the strength of the military forces. This is accomplished by the selection and enrolment for military service, through properly conducted physical examinations, of only those men physically fit for the performance of the duties to devolve upon them, by keeping such personnel in good physical condition through the application of modern principles of preventive medicine, and in furnishing those who do become disabled with such aid in the form of evacuation and hospitalization facilities as will speedily restore them to health and fighting efficiency.

This is a clear statement of our duty in general terms, and the manner of its performance in modern warfare may be appreciated when I tell you that, in the world war, 85 per cent. of the total number of American army battle casualties were returned to duty, and a total of 95 per cent. of the sick and ordinary injuries were returned to duty. And to those who do not know of the work of the medical service in combat, let me say in passing that though ordinarily considered "non-combatants," the casualties in our

[1] The fourth annual Delta Omega lecture at the Massachusetts Institute of Technology, April 3, 1931. The Delta Omega lecture is delivered each year before the chapters of the Delta Omega Society of the Massachusetts Institute of Technology and of the Harvard School of Public Health, and to it the public is invited. The Delta Omega Society, to which selected students of public health are admitted, was founded in 1924 at the School of Hygiene and Public Health of the Johns Hopkins University. Other chapters have been established at Harvard, the Massachusetts Institute of Technology, Yale, Michigan and California.

department at the front in the great war were second only to those of the Infantry. Just consider that there were, in proportion, more men killed or wounded among the officers and enlisted men of the Medical Department than among those of the Artillery, Air Service, Cavalry, Signal Corps or Engineers who saw front-line service.

I do not propose discussing to-day the work of our corps in its purely military duty. That would be of only secondary interest to you as public health men. Though there can be no really essential difference in the work of the military sanitarian and his civilian confrère, there are certain aspects and limitations of the work of each which I propose to mention. The fear of "state medicine," that bugbear of the general practitioner, has at times led to ill-founded statements and distortion of facts regarding the federal services.

Military sanitation is the prevention of disease in armies. More specifically it consists in the practical application, under diverse conditions met in the field and camp or permanent garrison, of a system of principles relating to the preservation of health. It embraces all the details which relate to public health, in a civil community, and in addition must take cognizance of other factors which either do not enter into or can not be controlled in civil life.

While the civilian health officer has to deal with the population as he finds it, the military sanitarian can choose the bulk of his human material in the form of recruits, the proper selection of the soldier constituting one of the most important requirements for attaining satisfactory health conditions and the greatest degree of military effectiveness. The fundamental reason for military sanitation is not humanitarian, but increased military efficiency and the application of sanitary principles adapted to the requirements of the military machine assist in the struggle for victory.

I do not mean to imply that civilian health officers should not be interested in military sanitation. Quite the contrary. Wars are now waged not by armies alone, but by the entire resources of personnel and matériel of nations. This can not well be otherwise in view of the possibilities of the wars of to-day and to-morrow, and we must face these facts, whether we like them or not. In the broad sense were we to be drawn into a war now, each one of us, including you, would, in a measure, be called upon to practice military sanitation and military preventive medicine, and this holds true whether we have a large army, a small army or no army at all.

In time of peace, a military command living at an army post is composed of individuals, not excepting civilians of all ages, under a much more complete control than is possible outside the service. Obviously the military health officer's work is rendered more simple thereby. He has but one man to convince of the desirability of the step that he recommends, and that man is the commanding officer. The commanding officer is responsible, and, having been convinced, can issue a military order which will be binding upon each and every soul, living upon the post. Civilians not wishing to comply with such orders are not permitted to remain. Of course such a condition requires complete confidence in the health officer, or medical inspector as he is called in the service, on the part of the commanding officer. A commander who does not trust the ability and knowledge of his medical advisers usually is not slow in taking steps to secure their replacement. On the other hand, the military officer of health has special difficulties. His great power is at once a source of weakness. He is immediately blamed for anything that goes wrong in a medical way, and usually he has to carry the responsibility alone. Military personnel are by the very nature of things unable to live in the same way as civilians. There are medical conditions incident to overcrowding, exposure and long hours, problems concerned with the supply of potable and sufficient water in the field, the disposal of body and other wastes when on the march and in camp, venereal infections, and many others, all of which must be considered in a different light from that in which the civilian health officer labors. The recommendations made must be adapted to the necessities in each case.

The greatest of all differences in the recommendations of the military as contrasted with the civil health officer is that of objective. The civil health officer knows no higher law than the preservation of human life and health. Other considerations are secondary. But in the army the military necessity must come first. This is, of course, considerably less so in time of peace than in war, but the difference is always felt. The medical inspector in the army may know that to order soldiers into a certain locality will inevitably result in increased incidence of disease or even loss of life, yet such orders may be necessary and therefore, to a soldier, desirable. A medical officer who merely recommends against such action, relying on the fact that it is not himself but the commander who must bear the responsibility, or who otherwise offers only destructive criticism, is not worthy of his salt. He is, under such circumstances, merely an *objector*, a "no-man," far more deadly than the "yes-man," to use a bit of army slang. So the military officer of health must possess a sufficiently broad knowledge of his subject to be able to offer sound advice in such times of stress or in handicap conditions. A mere recollection of rules of thumb will not suffice him.

With modern advances in preventive medicine and the consequent increasing degree of protection from communicable diseases afforded the children and youth

of the nation, special problems arise for the military health officer. More and more of such children attain adult years without having acquired immunity to certain diseases by having had them, or with low resistance to some of the common communicable diseases. This has an important bearing on mobilizations of troops that may be necessary in the future, as well as in the peace-time problems of army life. Recruits are having a higher and higher group susceptibility not only to those diseases of which one attack confers permanent immunity, but also to those, resistance to which is developed by repeated exposure or attacks.

Entirely aside from all this, military medical officers in their turn must at all times be interested in every means of preserving the health of our whole population and of preventing diseases in general. This phase of our task will be of more interest to you than the other.

"When," as Surgeon-General Ireland says, "the profession of public health has made an advance, the army has advanced with it, and occasionally it has led the profession." Our corps is a small body consisting of less than a thousand medical officers, and as this group has the task of providing medical and surgical attention of every sort to the army and its dependents, at home and abroad, there can be but a comparative few whose duties are spent chiefly in the field of public health and hygiene.

Let me run over some of the work that our officers have done in this field in the past. In other words, let me recall to you some of the contributions to sanitary science of members of the medical department of your army. I limit myself to career medical officers or those whose work has been performed while they were in the service. Otherwise I should merely be reviewing the work of American medical science in general, for in time of war practically the entire medical and public health professions have been and will again be at the service of the government.

Our army medical department has numbered on its rolls not a few of America's foremost men of science. As early as the Revolution, Washington's army included such men as John Morgan and William Shippen, both graduates of Edinburgh and successively directors general of the army. They were leading pioneers in medical education and the principal founders of the medical department of the University of Pennsylvania, the oldest medical school in this country (1765). Associated with them in the Continental Army was an even more distinguished officer, Benjamin Rush, likewise an Edinburgh graduate and sometime physician general of the Middle Department. He succeeded Morgan as professor of practice in the College of Philadelphia, and was the founder of the Philadelphia Dispensary, the first in America (1786). He was the ablest clinician of his time, a signer of the Declaration of Independence, and dubbed by Lettsom the American Sydenham. His monograph on insanity was the only systematic treatise before 1863, and of particular interest to us as public health men is his well-known account of the Philadelphia epidemic of yellow fever to which I shall refer later. He also wrote a valuable pamphlet on the hygiene of troops (1777), and his papers on the American Indian are considered the first American contributions to anthropology.

The earliest American pharmacopoeia was that prepared for the use of the Continental Army by William Brown, of Virginia, who succeeded Rush as physician general of the Middle Department. It appeared in Latin in 1778. The first surgical work published in this country was from the pen of John Jones, a soldier of the French and Indian, and Revolutionary Wars, and as it included an appendix on camp and military hospitals, it must be reckoned the first American book on military medicine.

James Tilton, one of the early surgeons general after the Revolution, introduced the "hut system" during the war to avoid overcrowding of hospitals, a step much in advance of the then prevailing usage in this and other countries.

In 1834, Joseph Lovell, the first surgeon general of the army under the reorganization of 1818, introduced competitive examinations for admission to the Medical Corps, one of the two administrative measures for which he is remembered, the other being the abolition of the whiskey ration—a valuable step, though hardly popular with the general public of those pre-Volsteadian days.

The surgeon general of the army just after the outbreak of the war of 1861 was William Alexander Hammond, who made his mark as a physiologist by his essay on "The Nutritive Value and Physiological Effects of Albumin, Starch and Gum when Singly and Exclusively used as Foods," which won him a European reputation, the medal of the American Medical Association (1853) and the chair of anatomy and physiology at the University of Maryland, in 1860. He continued Tilton's provisions for the prevention of overcrowding by the extensive construction of hospitals upon the pavilion system. And he did more. In the words of another great military medical officer, Weir Mitchell, "he duly saw and grasped a great opportunity, and served his country as few could have done"; he created the Army Medical Museum, now the largest institution of its kind in the world. His systematization of medico-military reports led to the compilation, under his administrative successors, of the extensive "Medical and Surgical History of the War of the Rebellion" (a title that possibly would not

have been chosen to-day), "with the publication of which," said Virchow, "began a new era of military medicine." It was the prototype of the even larger "History of the Medical Department of the U. S. Army in the World War." Another of Hammond's contributions was his cutting of calomel and tartar emetic from the supply table of the army. This may seem a small matter to-day, but not if we recall the once orthodox practice of producing and ascribing wonderful curative properties to mercurial salivation and mild antimonial poisoning. Nor must we suppose that the medical profession received Hammond's action calmly, for a great cry was raised. Under this chief the army planned and adopted the use of ambulances, thereby setting an example for civilian hospitals to follow later.

During the war of 1861 Assistant Surgeon Da Costa first described the irritable heart in soldiers (1862) and Assistant Surgeons S. Weir Mitchell, George R. Morehouse and William W. Keen made their investigations of gunshot and other injuries of nerves (1864) which have become classical. All these men are known to the world as the foremost American physicians and surgeons.

The war of 1861 produced another outstanding medical officer, John Shaw Billings, the father of the Army Medical Library, to be discussed later. Billings was the author of the best history of surgery that has been published in English, the designer of the Johns Hopkins and other modern hospitals and of the New York Public Library—certainly a wonderful contributor to scientific advance. His survey in 1870 of the Marine Hospital Service, then the sport of politicians, initiated the improvements and growth which have resulted in the present splendid U. S. Public Health Service.

One of America's pioneers in bacteriology was Surgeon General George Miller Sternberg, the author of the first manual (1893) and text-book (1896) of bacteriology as well as important treatises on immunity (1895), disinfection (1900) and infection (1903). He was the first to isolate what was then called the bacillus of croupous pneumonia (1880). He also did important work on yellow fever, and under his administration Major Walter Reed carried out his experiments on transmission of that disease, to be mentioned later. Sternberg, after directing the work of his corps through the Spanish-American War, in the face of legislative and administrative obstacles, established the corps of women nurses, organized the medical service of the new tropical possessions and established the Army Medical School. His service to the public health was attested by his having been elected president of the American Public Health Association as well as of the American Medical Association.

The contributions of the members of the Army Medical Corps to advancement of public health since the Spanish-American War are best understood by selecting for discussion the most important diseases of which our knowledge has been advanced by work of army officers.

TYPHOID FEVER

Typhoid fever was ever the curse of armies in the field, and it seems particularly fitting that army medical officers have taken such a prominent part in bringing it under control.

It is hard to ascertain with accuracy the number of cases in this country prior to the war of 1861, and even in that war such terms as "bilious remittent fevers," "typho-malaria," etc., were used to take the sting out of a diagnosis of typhoid fever, though the latter was made official in 1862 and from that time until June 30, 1866, there were 57,400 cases with 5,360 deaths reported under this name.

With the mobilization of troops for the war with Spain in 1898 this same fever spread rapidly through the camps, though reported under a variety of names. More than 20,000 cases of typhoid fever occurred in the military camps in the United States alone. A board of three medical officers was appointed to study the cause of the epidemics. Its members were Major Walter Reed (who while doing graduate work at Johns Hopkins had already made an important contribution to the pathology of the liver in typhoid fever), Major Victor C. Vaughan and Major Edward O. Shakespeare. Their careful investigations showed that more than 90 per cent. of the volunteer regiments developed the disease within eight weeks after going into camp, that typhoid fever is disseminated by the transference of the excreta of infected individuals to the alimentary canals of others, that camp pollution was a more prominent causal agent in this instance than contaminated water supplies, that the disease was largely spread by flies on the clothing and hands of human carriers, etc. In the epidemic of the Spanish-American War the deaths from typhoid fever were 86.24 per cent. of the total deaths, the morbidity from the disease being 151.05 per 1,000 of mean strength, the mortality being 15.82 per 1,000 of mean strength in a force of 107,973 men. A terrible story indeed!

The British were the first to practice immunization against typhoid fever. Sir Almroth Wright, then a professor in the Royal Army Medical College, began in 1896 to practice vaccination against this disease, the procedure being wholly voluntary. Despite Wright's work protective vaccination was not immediately adopted generally in the British service and in the Boer War of 1899–1902 all the mistakes of the American Army during the Spanish-American War

were repeated. Of a total strength of 380,653, there were 57,684 cases and 8,225 deaths, or a morbidity of 151.15 and a mortality rate of 21 per 1,000.

Discouraging reports of a "negative phase," following the inoculation against typhoid and unfortunate accounts of higher mortality amongst vaccinated troops in infected areas than in unvaccinated troops at less infected stations, resulted in the prohibition in 1903 of typhoid vaccination in the British service. Fortunately Wright's procedure was vindicated by the Royal College of Physicians and again put into operation, and, though it was not made compulsory, 82.3 per cent. of British soldiers in India received the treatment in 1910.

Major Frederick F. Russell, of the U. S. Army Medical Corps (a brigadier general of the reserve since his resignation from the regular army, and general director of the International Health Board), studying the results of British practice, began in 1909 the gigantic experiment of vaccinating the U. S. Army against typhoid. From a morbidity of 173 cases in that year he was able to bring the statistics down to nine cases in 1912 with but one fatal case reported. The officers and men who volunteered for his experiments are deserving of the thanks of their countrymen. In 1911 he was able to have vaccination against typhoid fever made compulsory and with the mobilization of our troops on the Mexican border in the following year he had ample opportunity to test results in the field. During this mobilization he vaccinated some 20,000 men against typhoid, and the only case that occurred in camp was that of a non-vaccinated teamster. Ours was the first army to take this step.

Then came the world war. At first the only one of the armies adequately vaccinated was the British. In 1914 alone there were more than 45,000 cases in the French army. In 1915 the rate per 1,000 was four for the British, 18 for the Italian and 10 for the Belgian armies. In this year there were more than 64,000 German and 125,000 Austrian cases (strength not known). And so it went. But the practice of protecting their men against this disease became more and more common until all the armies on both sides required it and in the last year of the conflict no army had a rate as high as one. The following table for the whole period of the war is interesting:

	Rates per 1,000 per annum	
Country	Morbidity	Mortality
France	14.86	1.81
Italy	6.24	.....
Belgium	3.59	0.57
Great Britain	1.02	0.04
United States	0.35	0.05

It has not been possible to obtain the accurate strength returns for the German or the Austro-Hungarian armies, but the absolute number of cases of typhoid fever was 112,364 and 171,601, respectively, both figures being higher than the number of cases in any of the allied armies.

Perhaps the most striking way of setting forth the value of the typhoid prophylaxis is to state that had the rates of the Spanish-American War been in effect at the period of the world war, the United States would have had not 1,572 cases of typhoid fever among its soldiers, but more than a half million.

YELLOW FEVER

In no disease have members of the Medical Corps of our army done more to advance the sum of knowledge and to reduce to its present restricted geographical limits than this terrible malady. Perhaps a better way to put it would be to say that we have the army to thank for our not having the wide spread of "Yellow Jack" that was such a real terror a generation ago. The disease is now all but a medical curiosity.

As early as 1793, Benjamin Rush, physician general of the Middle Department of the army, played an important part in fighting the epidemic of yellow fever in his native Philadelphia, and his account of his work is unapproached for its realism.

In 1820, Surgeon's Mate Merrill, of the 8th Infantry, outlined a new treatment of this disease, which, while perhaps not in keeping with modern clinical methods, at least had the merit of giving great relief to the sufferers in comparison with the extensive venesection and massive doses of purgatives that had been used up to that time.

When Carlos Finlay stated his theory of the insect transmission of yellow fever in 1881, a real step was made, and that great man of science, Surgeon General Sternberg, realizing the desirability of special training in methods of research, sent Major Walter Reed to Johns Hopkins to study pathology under Welch. In 1900 Reed was detailed as the head of what is probably the greatest of all army boards. It was to study yellow fever in Cuba, the disease still being supposed to be caused by the so-called *Bacillus icteroides* of Sanarelli. It may be remarked here that Sternberg's great contribution to our knowledge of yellow fever was his refutation of the mistakes of other workers and the indication that the causative microorganism of yellow fever was not to be found by ordinary bacteriological methods.

The other members of the Reed board were Majors James Carroll, who submitted to inoculation with the disease, Jesse W. Lazear, who died from the effects of an accidental mosquito bite, and lastly Assistant Surgeon Aristides Agramonte, a native of Cuba and at present professor of pathology at the University

of Havana, the only member of the board still living. [Dr. Agramonte has died since this lecture was delivered.]

In 1900, Surgeon Henry R. Carter, of the U. S. Public Health Service, had shown that a period of 12 to 15 days must elapse before a case of yellow fever becomes dangerous to others. This and Finlay's theory were the two principal facts upon which the board had to build. I shall not go into the details of the work of the Reed Commission, for the steps in their experiments are known to every student of bacteriological science. Dr. Turner has set forth the study in an account intelligible and interesting even to the layman. Suffice it to say that they were able soon to dispose of Sanarelli's bacillus (found to be identical with the *Bacillus X* of Sternberg) and proceed to attack the problem of transmission by mosquitoes, realizing also that yellow fever could hardly be a "filth disease," since the cleaning up of Havana by the American administration had not improved the situation in that respect. They showed that under controlled conditions, the bites of *Aedes aegypti* (then called *Stegomyia fasciatus*) caused yellow fever in volunteers; that the much maligned *fomites* had nothing to do with the transmission of the disease; and that the so-called "infected houses" were such solely because they harbored yellow fever mosquitoes.

Comments on the value of the work of Reed and his associates to the world have been many. General Leonard Wood, himself a distinguished officer of the Medical Corps and who while in command in Cuba did much to aid Reed, said:

> I know of no other man of this side of the world who has done so much for humanity as Dr. Reed. His discovery results in the saving of more lives annually than were lost in the Cuban War, and saves the commercial interests of the world a greater financial loss each year than the cost of the Cuban War. In the months when the disease was ordinarily the worst, it was checked and driven from Havana. It was the first time in two hundred years that the city had been rid of it. Hereafter it will never be possible for yellow fever to gain such headway that quarantine will exist from the mouth of the Potomac to the mouth of the Rio Grande. Future generations will appreciate fully the value of Reed's services.

And President Eliot, of Harvard, in admitting Reed to an honorary degree, expressed himself in somewhat the same terms.

In his annual report of 1902, the Secretary of War, Mr. Elihu Root, said with reference to the conquest of yellow fever in Cuba in 1900:

> The brilliant character of this scientific achievement, its inestimable value to mankind, the saving of thousands of lives, and the deliverance of the Atlantic seacoast from constant apprehension, demand special recognition from the Government of the United States.

Republics are said to be ungrateful. Certainly they are at times exceedingly slow in recognizing merit. It was not until 1929 that Congress approved an act to present each a gold medal and to publish annually in the Army Register a roll of honor of the names of each member of the Reed Commission and those of the 18 brave men who volunteered for the experiments in the mode of transmission of a disease that was second to none in the terror which it inspired.

The task of eradicating yellow fever from Havana fell to Major William Crawford Gorgas, later surgeon general of the army and the best known man who has held that office. Gorgas was appointed chief sanitary officer of Havana on February 10, 1900. Under General Wood's orders he instituted the measures now practiced everywhere in combating mosquito-borne diseases. He screened yellow fever patients, destroyed mosquitoes, etc., and in three months Havana was freed from the disease for the first time in 150 years.

The success of Gorgas in Havana led naturally to his being put in charge of similar work in the newly acquired Canal Zone in 1904. Here what had been a notorious plague spot of disease, the "White Man's Grave," as it was called, was converted into one of the healthiest communities in existence. Gorgas continued the methods which had proved so successful in Havana. In the face of much stupid opposition at first, Gorgas never hesitated in attaining his objective, that of making the isthmus free from disease before the operations on the canal were commenced. While the elimination of other diseases was no less important than that of yellow fever, this malady comes first in the minds of the general public. Under the French occupation it was a byword that every tile laid on the Panama Railway cost a life. From 1881 to 1889 the French lost more than 22,000 laborers by death, an annual rate of 240 per thousand. One station on the old Panama Railway was called "Matachin," from the Spanish words *matar* (kill) and *Chino* (Chinaman), because 1,000 imported Chinese coolies at this point died off in six months, as did also 1,000 Negroes from the West Coast of Africa.

When the United States took charge of Panama the death rate was 40 per 1,000. A yellow fever epidemic raged from July, 1904, to December, 1905. In less than a year Gorgas had eradicated it entirely and there has not been a single case of the disease there since May, 1906.

In one of his reports Gorgas said:

> When the Canal shall have been finished it can be shown that sanitation cost about $365,000 per year. For

a population of 150,000, this means an expenditure of about one cent per caput per day, and this sum is well within the means of any tropical country.

Elsewhere he says:

I do not believe that posterity will consider the commercial and physical success of the Canal the greatest good it has conferred upon mankind. I hope that as time passes our descendants will see that the greatest good the Canal has brought was the opportunity it gave for demonstration that the white man could live and work in the tropics, and maintain his health at as high a point as he can, doing the same work, in the temperate zone. That this has been demonstrated none can gainsay.

In 1906 during the period of our second intervention in Cuba, Major (now Brigadier General, Ret.) Jefferson R. Kean, a medical officer who had already been commended for his work in helping the Reed Yellow Fever Board, and curiously enough, the first yellow-fever patient that his friend Reed had ever seen, was placed in charge of sanitary affairs in the island by President Taft. This position he held throughout the entire period of occupation, and during this time he extinguished yellow fever, which had reinvaded the island during the first Cuban republic, and owing to the great increase in the non-immune population had spread all over Cuba. In 1900, when yellow fever had been extinguished in Havana, it disappeared from the entire island.

During the remainder of his life, even while he was surgeon general of the army, Gorgas was frequently called to distant parts of the tropical world to give advice and assistance. After his retirement from active duty, after having served as surgeon general through the world war, he was on his way to South Africa for the purpose of taking up yellow-fever work for the International Health Board, when, delayed in Europe by the award of many honors, he died suddenly in London, having been knighted on his deathbed by King George V. As Colonel Ashburn said, "He was a verray parfit gentil knyght."

The preventive measures used by Reed and Gorgas have been, and are being put into effect in many tropical lands. In his recently published report on "Twenty-Five Years of American Medical Activity in the Isthmus of Panama," a work received with enthusiasm in Britain, France and elsewhere, Colonel Weston P. Chamberlain, health officer of the canal, says:

By far the larger part of the morbidity and mortality formerly attributed by tropical *climates* was due, not to climate *per se*, but to isolation, nostalgia, venereal disease, alcoholic excess, poor municipal conditions, and, most important of all, *to infection with specific parasites whose invasion is now entirely preventable.* . . .

Commenting on which, Sir William Horrocks remarks, "This may justly be regarded as a triumph of preventive medicine."

MALARIA

Malaria has always been a disease of the greatest interest to the medical officers of all armies and certainly the greatest advances in our knowledge of the malady have been made by men of that profession. On November 6, 1880, Alphonse Laveran, a medical officer of the French army, discovered the parasite of malaria while serving with the troops in Algeria and in the following year described them in all their aspects. His four great treatises on palludism are classics. In 1897 Sir Ronald Ross, of the Indian Medical Service, then a major, demonstrated the anopheles mosquito as the vector of malaria, discovered the Laveran plasmodia in the stomach wall of anopheles which had fed on the blood of malarial patients, proved that one stage of the parasite is found in the salivary glands of the insect and devised methods of destruction of the insects, which he employed with success in mosquito reduction in Sierra Leone, Lagos, the Gold Coast and Ismailia. Both of these officers were awarded the Nobel Prize and other high recognition of their work.

But it was the Americans who gave the greatest demonstration of anti-malarial work. From 1898 onward our troops were instructed to use mosquito nets and otherwise how to avoid infection—the first army to adopt this measure. The work of Gorgas in Havana was directed mainly to the prevention of mosquito-breeding. During the same period when the yellow fever was being abolished in that city, its malarial incidence was reduced 75 per cent. Later the same administrator obtained the same results in Panama.

Malaria, as we all know, is not as easily eradicated as yellow fever because *Anopheles* (*Anopheles*) is not a domestic insect, as is *Aedes*, and the malarial patient, instead of being capable of giving the infection to the mosquito for three days only, as is the sufferer from yellow fever, is dangerous for weeks, months or even years. Malaria patients are also far more numerous than yellow-fever patients.

But the work goes on and witness the results thus far. In 1901 the incidence of malaria in the U. S. Army was 381 per 1,000; in 1902 it was 272; in 1907, 85; in 1926, eight; and in 1927, six; and for last year it was again six, and this is true even with the increase in malarial incidence following the floods of the Mississippi Valley.

Another medical officer whose work in malariology has been important is Colonel Charles F. Craig, who demonstrated that the intra-corpuscular conjugation

in the malarial plasmodia is the cause of latency and relapse, and of the existence of carriers.

Hookworm Disease

In 1900 Captain (now Colonel) Bailey K. Ashford, U. S. Army, discovered the great prevalence of hookworm disease in Porto Rico, and shortly thereafter it was found to be very prevalent among the rural population of the United States, by Dr. Charles Wardell Stiles, of the U. S. Public Health Service, who described the American hookworm, *Necator americanus*. Ashford devoted himself to the task of stamping out hookworm infection in Porto Rico and in 1903–4 treated some 300,000 patients, reducing the mortality by 90 per cent. This determination of the mode of combatting the long-dreaded "Porto Rico anemia" must be rated as a notable achievement in American hygiene.

Beriberi

When we took possession of the Philippine Islands our medical officers met for the first time the disease beriberi, a peculiar peripheral neuritis all too well known in the East. Many men died of it, particularly in the Bilibid Prison, in Manila and in the newly organized Philippine Scouts. It had been the scourge of the Japanese armed forces, but they had freed their navy from it by changing the rations of the men. In 1909, the U. S. Army Board for the Study of Tropical Diseases recommended that the ration of the Philippine Scouts be changed by the substitution of unmilled for the previously used highly milled rice, a substitution of beans for a part of the rice component of the ration and the prohibition of savings in the meat element of the ration. The admission rate for beriberi as a result fell from 604 in 1909 to 50 in 1910 and two in 1911, and it has been absent, or nearly so, ever since.

Later on, one of the members of the board, Captain (now Colonel) Edward B. Vedder, continued his studies of beriberi, including the infantile form, and his excellent monograph on the subject won him the Cartwright Prize in 1915.

Typhus and Trench Fevers

Typhus Fever: During the great war and the period which followed, American medical officers played an important rôle in campaigns against typhus fever, the age-old scourge of armies. Twice in Serbia, in 1915 and 1919, the epidemics of typhus, the most severe that the world had ever known, were brought under control. Almost as striking results were obtained in Poland.

Trench Fever: The American Red Cross Medical Research Commission showed that this disease, a common cause of non-effectivity in the world war, was due to a filterable virus and transmitted by body lice. The members of the American commission were medical officers of the army under the direction of Major Richard P. Strong, formerly of the regular service, and then a reserve officer.

Malta Fever: In 1898 Lieutenant Walter Cox first described Malta fever in the U. S. Army, and in 1911 Captains (now Lieutenant Colonels) Gentry and Ferenbaugh showed the disease to be endemic in our Southwest.

Physiology of Digestion

"Every physician," says Vaughan, "who prescribes for digestive disorders and every patient who is benefited by such a prescription, owes gratitude to the studies of William Beaumont, who in 1825, on the Island of Mackinac, began his studies of digestion, which he pursued with labor and skill for the benefit of mankind," making what Harvey Cushing calls "the most important contributions to the physiology of digestion made during the century."

Beaumont, a surgeon of the U. S. Army, described his lengthy study of an accidental gastric fistula in the Canadian half-breed, Alexis St. Martin. His "Experiments and Observations on Gastric Juice and the Physiology of Digestion" is a classic known to every student of physiology. He carefully reviewed the work of his predecessors, gave an accurate description of the normal and pathologic appearance of the gastric mucosa in life, the movements of the stomach up to the completion of digestion, showed that the gastric juice is secreted only when food is present and that mechanical irritation of the mucous membrane produces congestion, but only a limited local secretion of gastric juice, thus foreshadowing the work of Pavloff and overthrowing the doctrine of Magendie that gastric secretion is continual. Beaumont's experiments on the effect of gastric juice upon different foods and the relative nutritive values of the latter are in reality the foundation of modern dietetic tables, while his chemical examination of the gastric juice led him to the conclusion that it contains free hydrochloric acid plus some other active chemical substance, proved later by Schwann to be pepsin. The story of Beaumont's efforts to keep in touch with his temperamental patient, his expenditure of his own limited funds in his experiments, and his single-handed work, constitutes one of the most romantic episodes in the history of medical science. Beaumont served through the war of 1812 as a surgeon's mate and later was a surgeon at Fort Mackinac, Michigan, a frontier post frequented by Indians and trappers, where he met his patient, St. Martin. Beaumont General Hospital, U. S. Army, at Fort Bliss, Texas, was named in honor of this great medical officer.

Of Beaumont, Sir William Osler said, "His work

remains a model of patient, persevering investigation, experiment and research, and the highest praise we can give him is to say that he lived up to and fulfilled the ideals with which he set out and which he expressed when he said, 'Truth, like beauty, when unadorned is adorned most, and in prosecuting these experiments and inquiries, I believe I have been guided by its light.'" Osler himself planned to secure St. Martin's stomach for the Army Medical Museum, but when that celebrated patient died in 1880, an old man and the father of 20 children, Osler received a telegram, "Don't come for autopsy; will be killed," and St. Martin's neighbors guarded his grave by night.

Purification of Water

Brigadier General Carl R. Darnall, then a major, devised the first apparatus for the use of chlorine gas in the sterilization of water and was the first to apply liquid chlorine to this use. His priority is attested by basic patents in this as well as other countries, the validity of which has been upheld in the courts. His experimental work was carried out at the Army Medical School, of which he is now the head.

The Darnall filter was an important step in the solution of the problem of supplying potable water to troops in the field. The Lyster bag, devised by Colonel W. J. Lyster, for the chlorination of water in the field by means of calcium hypochlorite, is known to every person who has been in the army since the days of the Texas Border mobilization, and is still the most satisfactory method for this purpose. It is widely used in camps, not merely those of a military nature.

Meteorology

Meteorological data in the United States were first recorded by the medical department of the army in 1814. In 1819 Surgeon-General Lovell directed that the medical officers at each post record weather observations. Beginning with temperature readings only, there were soon added data on rainfall, wind direction, sunshine, cloud formation and precipitation of rain or snow. From these records in later years tables of mean temperature for different localities were prepared, and there followed the construction of weather maps by Espy, which became the forerunners of the Weather Bureau Maps of to-day.

In 1870 Surgeon Albert J. Myer, for whom Fort Myer was named, created the signal corps of the army and became the first chief signal officer. The Signal Corps took over the meteorological records that had been kept by the Medical Department, and continued them until 1890 when the Weather Bureau of the Department of Agriculture was instituted and undertook meteorological work for the country.

Periodic Physical Examinations

The annual physical examinations of army officers, recommended by the Medical Corps and put into effect in December, 1907, by order of President Roosevelt, was the first step towards a measure long practiced in the army and now universally recommended by public health agencies.

Public Health Education

I have already said that the medical department of the University of Pennsylvania, oldest medical school in America, was founded by two medical officers of the army, Morgan and Shippen; so from the first the Medical Corps has been a contributor to the cause of education.

In 1893, without any legal authorization, Surgeon General Sternberg established the Army Medical School, using at first the rooms in the building which then as now houses the Army Medical Museum and Army Medical Library. He detailed the faculty from officers having other duties in Washington, and in his choice of his instructors he, the great bacteriologist, chose wisely. It is not too much to claim that this institution was the first school of hygiene in America.

Later years have fully justified the inception of the school. Though there have been obvious and logical changes in its curriculum and methods of instruction, it has been, in general, used to give special instruction to young physicians just after receiving their commissions in the Medical Corps. For a long time they attended the school on a sort of probationary status (sometimes as contract surgeons, sometimes as officers of the Medical Reserve Corps, etc.) and on satisfactorily completing the course of one academic year, they received commissions as first lieutenants in the Medical Corps of the regular army. More recently an advanced course has been added for officers of field rank. Both courses stress preventive medicine, modern laboratory methods, tropical medicine, hygiene of troops on the march and in the field and the elements of sanitary engineering, that meeting ground of military and civil engineering. In 1923, the new and modern school building was opened at the Army Medical Center in Washington, near Walter Reed General Hospital, and the institution compares favorably with others of its type, such as the Royal Army Medical College at Millbank, London, and the French School of Application at the Val-de-Grâce medical center in Paris.

Shortly after the close of the great war, Congress authorized the army to detail officers, not exceeding 2 per cent. of the total commissioned strength, to scientific institutions of higher learning, for the purpose of pursuing courses of instruction in professional fields that would enable them better to perform the

duties of their grade and corps. The Medical Corps has, under the law, detailed officers of the Massachusetts Institute of Technology and the schools of public health of Johns Hopkins University, Harvard University and the University of Pennsylvania. So far a total of 26 officers have had the benefit of such advanced work, *i.e.*, in public health alone. A fair number of our officers have also completed the course at the London School of Tropical Medicine.

Another post-war development in the education was the Medical Field Service School established at Carlisle Barracks, Pennsylvania, in what had once been the Carlisle Indian School. Here both officers and men are given training in the military duties of medical officers and practical instruction in such subjects as field sanitation, military preventive medicine, sanitary engineering, etc. Here also is a special laboratory for the development of equipment and devices for use of the Medical Department of the army.

In the Philippine Islands there is maintained an important research body—the U. S. Army Medical Research Board. It was established in 1900 at the period just following the Spanish-American War, when the army found itself responsible for the government and health of several tropical dependencies, particularly the Philippines. The high incidence of tropical diseases constituted a menace to the army of occupation and interfered seriously with administration of the newly acquired territory.

The first members of this board were Lieutenants Richard P. Strong (now professor of tropical medicine at Harvard), W. H. Calvert, Assistant Surgeon Joseph J. Curry and Hospital Steward Dr. W. E. Musgrave. They issued in 1901 a valuable outline of the steps that should be taken to prevent the spread of plague, and by means of which the disease was controlled in Manila and kept out of the army. This was before the excellent work of the Indian Plague Commission had demonstrated the agency of the flea in the transmission of the disease.

The work of this board has solved many problems of wide interest in the field of public health. These include important contributions to the sum of our knowledge of cholera, typhoid fever, uncinariasis, yaws, leprosy, epizootic lymphangitis in horses, malaria, filariasis, etc. They showed, for example, that the long-known "hill diarrhoea" was due to the Flexner type of dysentery bacillus. One member (Vedder) demonstrated the amoebicidal action of ipecac (used theretofore empirically), and proved that it was due to the alkaloid emetine. He further showed that this compound is of no value in bacillary dysentery. They showed that diphtheria is far more prevalent in the tropics than had been thought. They pointed out that tuberculosis is two and one half times more common in Filipinos than in Americans. They demonstrated that the horsefly *Tabanus striatus* is the common vector of surra, the most serious disease of horses in the Philippines. An improved vaccine for rinderpest was produced. They proved that canning does not destroy the anti-scorbutic vitamin, a discovery of importance since scurvy was not uncommon. Vedder's work on beriberi has been mentioned.

The board first showed (1925) that the infective virus of dengue is in the circulating blood and that the disease is transmitted by the mosquito *Aedes aegypti*. This was a fitting climax to long work by members of the Medical Corps, begun by Benjamin Rush, who first recognized and described this disease a century ago, and continued since that time by many workers, notably, Colonels Charles F. Craig, Percy M. Ashburn, Joseph F. Siler and others.

In the field of climatology, it was shown that the effect of tropical light on white men is no more deleterious to blondes than to brunettes.

Another important army educational institution is the Army Medical Library. Billings founded what was long called the Library of the Surgeon General's Office, as has been said. This collection of the literature of the medical sciences is one of the greatest in existence. It contains more than a million items, subscribes to some 1,500 journals, and publishes what has been called America's greatest contribution to medicine, *i.e.*, the Index Catalogue of the library and the Index Medicus. The Index Catalogue lists the medical literature of the world as classified and filed in the library. It has completed two alphabetical series and the third series to include the letter P, and thus far embraces 45 volumes of octavo size and about 1,500 pages each. This catalogue is used throughout the civilized world. As a period of 15 to 20 years is necessary for the completion of an alphabetical series, a given subject, for example, typhoid fever, will appear but once in that time. To supplement the catalogue and enable the investigator to locate references to his subject in the current literature, Billings began the Index Medicus, a monthly index of the new medical books and articles appearing throughout the world. Unlike the Index Catalogue, which is a government publication, the Index Medicus never was and it always lost money. The expenses were for a long time defrayed by the Carnegie Institution and it is now continued as the Quarterly Cumulative Index Medicus of the American Medical Association, a necessity as well as a blessing to the medical investigator and writer.

In this library, Colonel Fielding H. Garrison, the best-known American authority on the history of

medicine, has spent his life and done his work. Since his retirement from active service he has been librarian of the Welch Memorial Library at the Johns Hopkins Schools of Medicine and Hygiene.

Unfortunately, the scope of my talk to-day does not permit of a description of Munson's experiments on the footgear of the soldier and his development of the "Munson last" for shoes, now in use in our own and several other armies, of his important work on leadership and his directorship of the morale branch of the general staff during the world war; of Lagarde's valuable work on gunshot wounds in which he disproved the old idea that wounds from bullets are sterile; of Letterman's system of the evacuation of the wounded, a revival of the work of Larrey, surgeon-in-chief of Napoleon's *Grande Armée,* and many others.

One might likewise note the work of distinguished medical officers in other branches of the army. I have already spoken of the creation of the Signal Corps of the Army by Surgeon Albert J. Myer in 1870. Major-General Leonard Wood, a great military leader and chief of staff of the army, was an officer of the Medical Corps, as was also, and at the same time, the adjutant general of the army, Major-General Fred C. Ainsworth, who devised the present system of record keeping. More recently an officer of the Medical Corps, Major General Harry L. Gilchrist, after having distinguished himself in research in his chosen field, was appointed chief of the Chemical Warfare Service. He is a national authority on the effects of chemical agents on animal life and his knowledge is of great benefit to industry as well as in the protection of human life.

It is hoped that I have given the impression that medical officers of our army have by their achievements held their own in comparison with the great medico-military officers of other nations, such as John Hunter, Sir Ronald Ross, Sir William Leishman (sometime director of the British Army Medical Services), von Graefe, Vincent of angina fame (sometime director of the French Army Medical Service), Helmholtz, Cohnheim, Loeffler, von Behring, Laveran, Widal, Pirogoff and others.

I think also that it will have been seen that what our branch of the United States Army has done compares favorably with the so-called "civil" accomplishments of the army as a whole, such as the digging of the Panama Canal, the construction of early railways, the building of the Capitol, Washington's Monument, the Library of Congress, etc., in Washington, the Lewis and Clark Expedition to the Northwest Territory, the expedition of Pike (of Pike's Peak), rivers and harbors work, the conduct of affairs after the San Francisco earthquake and the rest.

Sir Thomas Lewis recently pointed out that not only may medicine be divided into the usual divisions of individual and collective medicine, that is, general practice and public health, but public health itself may be divided into curative preventive medicine or herd treatment, and progressive preventive medicine or herd-pathology. In pure curative medicine the diagnosis is the main end-point whose object is to recognize the known in order to administer the correct established remedy. The worker in pure progressive medicine has no interest in the known except as a starting point to reach out into the unknown. To the scientific investigator the individual, or even the community, is of no importance or interest unless as material to help the progress of scientific medicine. In so far as he is allowed any humanitarian interests at all, the researcher works largely for the future and is glad if during his lifetime any of his work should prove useful in presenting applied medicine with new methods of diagnosis or treatment.

The Medical Corps of the army, as well as some of the other federal departments, offers an exceedingly attractive field to him who has the craving for research, who yet is not sufficiently enthusiastic to slave for the best part of his life in a laboratory in the average research position with its, for shame be it said, comparatively low financial return. Though in the service it is the medical officer's duty to give his first attention to the practice of preventive and curative medicine, he may also find plenty of time and encouragement from those in authority over him to carry on research. The income of the medical officer of the army is not large—I shall tell you in a moment just what it is—but it has one great advantage. It is not liable to be altered or suddenly cut off through the whim of a politician, or the turn of the wheel of chance. It is, as I once heard an old Kentucky judge remark about his salary, which was notably less than he might have earned in the practice of law: "It's not much, but it's awful regular."

The medical officer of the army enters with the grade of first lieutenant. That he does not begin with the lowest grade in the military scale of rank is a recognition of the long period of study that he must spend in preparation. The pay of the first lieutenant, including all allowances, averages approximately $3,100 per year. After three years he is promoted to captain and receives $3,900 per year. After 12 years he becomes major and receives $5,500. In 20 years he is a lieutenant colonel, with a salary of $7,200 and in 26 years as a colonel he receives $8,000. Promotion beyond that rank is by selection.

The medical officer, particularly the medical officer engaged in public health work, is one of the army's

best contacts with the civil community. Balfour says, "If the International Health Board of the Rockefeller Foundation had not the word 'health' in its title, its manifold activities would never have been received with complacency and gratitude by countries not owing allegiance to the Stars and Stripes." That word "health" is a talisman which can successfully unlock many a domestic as well as foreign door. There are occasions when civil authorities do not cooperate in a satisfactory manner with the military, particularly in times and places where there is a real or possible overlapping of authority. But it is hard to imagine a situation in which there is friction between the military and civil officers of health. Indeed, many a wise military commander has, by means of the friendly relations between the medical officers of such commands and their civilian colleagues, brought about a complete understanding and team work with civil authorities.

"The Services," says Dudley, "are the happy hunting ground, and one of the last strongholds of the amateur researcher. The word amateur here is used in its literal sense, not one who does something worse than a professional, but one who does something for the love of doing it. We may only be amusing ourselves, but if something useful emerges from our pastime so much the better, but that is not the main object of amateurs. While we may not wholly agree with the professor who at the end of a lifetime spent on some academic research said, 'Thank God I have never done anything practical,' yet in these sordid times one can not but sympathize with his sentiment."

When the medical officer of to-day thinks of what his predecessors have been able to achieve, of what practical good has come of their experiments, amateurish though they may at times have been, for all have not the facilities of the Army Medical School, the Tropical Board, etc., within reach, of the outcome of patient observation, of the productive results of the application of scientific principles and sound logic he may, with a feeling of pride and hope, continue his task in the realization that his efforts are not only "for the good of the service," to use a military catch-phrase, but likewise for the good of the whole nation.

OBITUARY

RICHARD ALEXANDER FULLERTON PENROSE, JR.

December 17, 1863–July 31, 1931

THE well-traced roots of the Penrose family, one might more accurately say clan, thread their way back to Cornwall before William the Conqueror sought the shores of Britain. For hundreds of years the name of Penrose is intertwined with the activities of that land, and in many instances it stands out conspicuously, whether in the field of knighthood, in law, in diplomacy, in religion, in politics, in education, in commerce or in battle by land or sea. They were also a daring and venturesome people and not at all averse to seeking opportunity in distant lands.

At the seaport of Bristol, in Gloucestershire, England, there lived one Bartholomew Penrose, who with his brother Thomas conducted a ship-building business. Much direct trading with Philadelphia was carried on from this port and it was but natural that stimulating stories of the possibilities of the new land over seas and the great success which was being achieved under the guidance of William Penn should have reached the ears of young Bartholomew and made him eager to go adventuring. About the year 1700 he landed in Philadelphia, and having an excellent social standing and skill in ship-building and sea commerce, he was soon well married and launched on a prosperous career. Thus was the Penrose strain transplanted in Pennsylvania, and whether in public or private life its achievements and rewards in the new world equalled those in the old. High mentality, combined with sound business sense, seems to have been the dominant characteristic of the Penroses wherever they were found and under whatever conditions they lived.

With such a background there came, in the seventh American generation, to Richard Alexander Fullerton Penrose and his wife, Sarah Hannah Boies, at the old homestead, 1331 Spruce Street, Philadelphia, on December 17, 1863, a fourth son, who was named after his father. This boy was richly endowed with the best of the Penrose ancestral traits, and he seemed to have missed out completely in respect to any undesirable qualities which may have existed in his forebears. His was preeminently a scientific mind, and, though engaging in many mining activities which had their roots deep in geology, he never lost his keen and active interest in this department of science. It always occupied the first place in his long and useful scientific life.

He graduated, with highest honors, from Harvard in 1884, and became a member of the Phi Beta Kappa Society. He remained at Harvard for postgraduate work till 1886, receiving the degrees of A.M. and Ph.D. It is noteworthy that his thesis for the latter degree, "The Nature and Origin of Deposits of Phos-

phate of Lime," was promptly published by the U. S. Geological Survey. A complete bibliography of his many writings will appear in the memorial to his memory in Vol. 43 of the *Bulletin* of the Geological Society of America, with which he was intimately connected from 1889 until his death and of which he was elected president in 1930.

On leaving college he took up active field geology, as shown by the following quotation from a statement prepared in his office before his death:

In 1888 he was Geologist in Charge of the Survey of Eastern Texas for the Texas Geological Survey; in 1889 he was appointed by the Geological Survey of Arkansas as Geologist to make investigations in the geology of the manganese and iron ore regions of that State; in 1892 he was appointed Associate Professor of Geology at the University of Chicago; and in 1895 he was made full Professor of that subject at the same university. He was lecturer on Economic Geology at Stanford University, California, in 1893; and in 1894 he was appointed Special Geologist of the United States Geological Survey to examine and report on the gold districts of Cripple Creek, Colorado. Still later he was engaged in geological work in different parts of the United States and in various other countries and in the pursuit of his investigations he visited almost all the countries in Europe, Asia, Africa, South America and elsewhere. One of his most elaborate trips was across Siberia before the Trans-Siberian Railroad was completed.

Dr. Penrose was connected through memberships and otherwise with at least two score of scientific organizations devoted to research or publication, his especial favorites being the American Philosophical Society and the Geological Society of America.

He combined with his fine scientific attainments a keen sense of sound business methods and a complete knowledge of the pecuniary rewards to be obtained from walking wisely in the market place. He even went so far in the business world as to accept half a dozen directorships, but they were in enterprises intimately related to his many interests in the field of mining. Soon after leaving college he had interested himself in copper deposits from a commercial as well as a scientific standpoint. He knew every copper district in the world, and when a new field was discovered he usually visited it personally or otherwise made himself thoroughly familiar with its character and possibilities. He was well acquainted with security values and the influences affecting them, as evidenced by the fact that he left an estate of approximately ten million dollars. After payment of all taxes, obligations and bequests there were available about eight and a half million dollars for distribution equally between the American Philosophical Society and the Geological Society of America. A rare combination indeed of scientist and financier.

Why he chose to lead a single life, only he knew. He was a man of great personal charm, gentleness of nature, courtly address and irreproachable life. Apparently geology was his first and only love. There seemed never to have been any wooing time for him. He was a member of a number of well-known clubs, but in no sense was he a club man. The old homestead in Spruce Street provided him a fireside, though in later life he occupied a suite of rooms in the Bellevue-Stratford in Philadelphia, where he was protected from intrusion and could come and go at his pleasure and on a moment's notice.

Dr. Penrose lived a full, rich life. He was not only a devoted, high-minded scientist but a genial enlightened gentleman with whom it was a pleasure to associate and a benefit to have known. Even in his last hours his thoughts were of the two societies to which he was so deeply attached and he so ordered his estate that they could both carry on in fuller measure and further advance the welfare of the world through research.

JOSEPH STANLEY-BROWN

At a meeting of the council of the Geological Society of America, held at Columbia University, New York, on October 17, the following resolutions were unanimously adopted:

Be it Resolved,

That in formally recording, in the minutes of this meeting, the death of Richard Alexander Fullerton Penrose, Jr., The Geological Society of America, through its Council, desires to express its deepest regret that he should not have been spared for many more years of useful work, and also its high appreciation of his fine personal character and his exceptional attainments in the field of geology. By his individual efforts and through his ever ready and generous cooperation with others, he did everything in his power during a long and successful life to promote activity in the field of research so dear to him.

Be it further Resolved,

That the society recognizes, with profound gratitude, that in carrying out a high ideal he has made it possible, through his magnificent generosity, to further advance in a large way, even after death, the science to which he devoted his life. In his last hours his thought was for the Society and he has not only handed to it a flaming torch but the means for keeping its sacred fire forever burning. Such a trust carries, in thought and deed, an obligation of loyalty such as Dr. Penrose always gave to the Society and to his colleagues.

And be it further Resolved,

That an engrossed copy of these resolutions be forwarded to Mr. Spencer Penrose, the sole surviving member of the immediate family.

RECENT DEATHS

DR. OLIN H. LANDRETH, professor of engineering at Union College from 1894 to 1919, when he was appointed professor emeritus, died on November 5, aged seventy-nine years. Previous to 1894 he had been professor of engineering and dean of the engineering department at Vanderbilt University.

DR. EDWARD H. JENKINS, director emeritus of the Connecticut Agricultural Experiment Station, died at his home in New Haven on November 7 at the age of eighty-one years.

MR. LEWIS TAYLOR ROBINSON, engineer in charge of the general engineering laboratory of the General Electric Company, died suddenly from a heart attack at his home in Schenectady on November 3. He was sixty-three years old.

THE death is reported from Dresden, at the age of sixty-six years, of Professor Dr. Ing. Fritz Foerster, who had been connected with the Dresden Technical Institute for the past thirty-one years.

THE *British Medical Journal* reports the deaths of the following medical men: Dr. Louis Goudard, a former president of the Medical Society of Paris; Dr. Ducamp, professor of clinical medicine at Montpellier; Dr. A. Besson, of Paris, author of a work on microbiological and serotherapeutic technique, and Dr. Piana, for twenty-five years director of the Radiological Institute of Genoa.

SCIENTIFIC EVENTS

THE BERMUDA FRESH-WATER SYSTEM

THE first fresh-water system in the history of Bermuda, regarded for centuries as impossible of achievement, will be opened for public use on November 30, according to Professor W. D. Turner, of the department of chemical engineering at Columbia University, who planned and directed the construction. He states that drain water caught on the house tops and frequently polluted to a high degree, has served the residents of the island for generations. New York's water supply would be condemned if it contained as much as one *Bacillus coli* per cubic centimeter, while water is considered good in Bermuda if it contains not more than 100.

Professor Turner writes:

> In Bermuda most of the rock is of porous coral, filled with small cavities and fissures. After a survey of the island we selected a small hill near Hamilton, capital of the colony, believing that the fresh water filtering through the rock crevices might be collected. A trench about 250 feet long and four feet deep was dug at the base of the hill. The bottom of the excavation was approximately a foot above sea-level and sloped gradually to a pump pit.
>
> A pipe line was laid in the trench with open joints so that water might find its way into the pipe and thence to the basin or pit. By concreting the basin, which, of course, was dug below sea-level, we prevented sea-water from seeping in. This was one of the points which was overlooked in previous attempts to tap a fresh-water supply.
>
> From the collecting basin the water will be pumped into a new reservoir which is practically completed at Pymwood, near Hamilton. From that point the supply will be piped to the capital city and perhaps to St. George's, the old capital, twelve miles from Hamilton.

After the trench was covered over and the basin complete, Professor Turner tested his "horizontal well." For three months a two-inch stream was pumped out of the pipe line day and night. The water was allowed to gush over a nearby golf course. New Yorkers use three times as much water as the residents of Bermuda. Hotels are the largest consumers on the island because of their American guests. The capacity of the island system is 300,000 gallons. In the United States this supply would meet the demands of a community of 3,000 persons. The population of Hamilton is 6,000, but because of the conservative use of water in Bermuda the new system will more than meet the demand. Since they have been using rain water for 300 years, the people are used to very soft water. In order to meet this requirement, the new system will include a water-softening plant, which will also remove the soil bacteria. The hardness is due to carbonate and hence can be removed by lime. The average rainfall is 60 inches annually, approximately the same as that of New York and New Jersey. It is estimated that the trench will collect about 50 per cent. of the water-fall. The well may be extended to increase the supply in event of additional demands.

The new water system, which will be known as the Bermuda Water Works, was financed by Mr. H. W. Watlington, philanthropist and a member of the House of Assembly. Construction work was started in the summer of 1930.

TOPOGRAPHICAL MAPS

THE U. S. Coast and Geodetic Survey, with the aid of time signals sent from the U. S. Naval Observatory, is planning to utilize the stars at several points along the Mississippi River for scientific calculations. The expert in charge of this work, Mr. Joseph P. Lushene, will use the data from his observations to adjust an arc of triangulation from Chester, Illinois, to St. Paul, Minnesota. These arcs of triangulation

are of importance to engineers and others in private industry. Engineers can get exact geographical information of a piece of ground, as to its elevation, latitude and longitude, that would cost large sums of money if this work were to be carried out by the individual.

The survey engineers have been engaged for a number of years on a "triangulation plan" of the 3,000,000-odd square miles of the United States, setting bronze markers at various points in order to fix the basis for a system of topographical maps which will be available to any engineer or scientific man.

Mr. Lushene will call to his aid another branch of science, the radio, in helping him to simplify his observations and calculations. With the aid of a radio, complicated scientific observations, ordinarily taking two or three nights, can be completed in a single night.

Longitude determinations, which are made by comparing the time from observations on the stars as they pass the meridian at the field stations with the time signals sent from the U. S. Naval Observatory in Washington, are exceedingly accurate. This comparison gives the difference in time between the seventy-fifth meridian and the field station, and the difference in longitude thus becomes known.

A single observing party is all that is now needed in the field, while before the radio came into use, it was necessary to have two observers, one at a point whose longitude had previously been determined and the other at the new station. The stations had to be placed within a reasonable distance of a telegraph line, for otherwise great expense would be involved in connecting by wire the telegraph line and the observatory.

This meant very little freedom of choice in the location of the longitude station, and the triangulation often had to be expanded in order to make connection with the astronomical station. With the radio there is no restriction as to the location of stations except that high mountain peaks are not used for longitude determinations because of the difficulty of carrying the instruments to the top. In general, stations are used to which the automobile truck that carries the astronomical instruments can be driven.

The radio is of value not only to the geodetic engineer in the determination of longitude, but for the same purpose to the navigator of a ship. To-day the navigator can use an ordinary pocket watch, receive his time signals by radio and be able to determine his longitude with greater accuracy than previously, when he had to depend on the constancy of the rate of the chronometer.

THE AGRICULTURAL EXPERIMENT STATIONS

FUNDS for the support of the agricultural experiment stations "are being carefully safeguarded and, to an increasing extent, restricted to intensive and productive research," according to the annual report of the Office of Experiment Stations, made public on November 6 by the U. S. Department of Agriculture. The report states that 1,000, or more than 15 per cent., of the 7,000 or more distinct lines of agricultural investigations in which the stations are now engaged are carried on in cooperation with the department, thus extending the scope and increasing the efficiency and usefulness of the work.

The report shows that federal, state and other funds, amounting to about $18,000,000, of which $4,340,000 was available from federal sources, were expended by the experiment stations in the year ended June 30, 1931, in a wide range of agricultural research.

Stations in Alaska, Hawaii, Porto Rico, Guam and the Virgin Islands report progress in efforts to diversify the agriculture of these regions and to make it more profitable and self-sustaining. The appropriations for these stations for the year were: Alaska, $85,300; Hawaii, $45,200; Porto Rico, $59,200; Guam, $30,200, and the Virgin Islands, $30,300. The Virgin Islands station received in addition $16,700 from other sources for use in expanding its work to meet emergency conditions on the islands.

An important event of the year affecting the Alaska experiment stations was the transfer of the station which has been in operation at Fairbanks since 1907 to the Alaska College of Agriculture and School of Mines, thus giving the local institution greater participation in the experimental work.

Coordination of the work of the former federal experiment station in Hawaii with that of the University of Hawaii is reported to be proving satisfactory and to be resulting in a widening of the field of activity and an increase of interest in the work.

The report points out that Congress recently extended to Porto Rico in a modified form the Hatch, Adams and Purnell Acts. The acts provide that the work of the existing experiment stations and the activities of the U. S. Department of Agriculture in the island shall be coordinated by the Secretary of Agriculture and conducted jointly and in collaboration. Preliminary steps were taken to bring about this coordination.

The Guam station reports continued success in efforts to bring about diversification of the agriculture of the islands and to develop extension work. Following the establishment of a civilian government in the Virgin Islands, and in view of the serious economic and food conditions in the islands, the experiment station suspended some of its usual activities and devoted its energies to encouraging the people to plant and cultivate gardens as a relief measure.

Steps were also taken to improve the bay-oil industry and to reestablish the growing of cotton.

A NEW HARVARD OBSERVATORY

ACCORDING to an article in the *Harvard Alumni Bulletin* the Harvard College Observatory will have in the near future a new astronomical observing station on Oak Ridge in the town of Harvard, Massachusetts, 27 miles northwest of Cambridge. The station will be on a ridge at an altitude of 600 feet, the highest point between Mt. Wachusett and the sea. The site is the gift of Mr. and Mrs. Alfred C. Fuller, of Belmont.

At this station the new 60-inch reflector telescope, the largest astronomical instrument in the eastern part of the country, will be the most important part of the equipment, but five or six of the observatory's photographic telescopes will be moved from Cambridge to the new station. Four photographic telescopes and the visual telescopes will be retained and operated at the headquarters on Observatory Hill, Cambridge.

It is estimated that telescopic power will gain on Oak Ridge a whole magnitude beyond that obtainable at the present site in Cambridge. This difference in brightness corresponds to a doubling of the number of stars within the reach of the various photographic telescopes.

The construction on Oak Ridge will include the building and turret for the 60-inch reflector, three buildings for the other telescopes, and a central building containing dark room, clock room, working library, storage and quarters for one or two observers. Also two or three separate cottages will be constructed for those members of the staff who will remain permanently on Oak Ridge. The architects are Coolidge, Shepley, Bulfinch and Abbott, of Boston.

The new site for the Harvard Observatory has been made imperative by the decision that the northern-hemisphere station should be equipped with a large reflecting telescope comparable to the one almost completed for the southern station in South Africa.

A dozen possible sites have been examined by the Harvard astronomers during the past six months, and the Oak Ridge station was selected as the best in eastern Massachusetts. The land comprises more than thirty acres of woodland; the woods will provide protection against wind, dust and stray light from neighboring villages, farmhouses and highways.

Some of the equipment will be in position at Oak Ridge and systematically operated on the regular photographic observing programs before next July. The three patrol cameras, which nightly photograph large sections of the sky to record the positions and brightnesses of the million or more stars that are within their reach, will be part of the Oak Ridge equipment.

It is probable that the 60-inch reflector, which should be ready for installation in fifteen months, and for operation a few months later, will be operated in part by members of the staff living in Cambridge, who will drive to the country for their observing assignments.

Beside the 60-inch reflector, the instruments at Oak Ridge will include the 24-inch reflector and the 16-inch Metcalf doublet; the 16-inch is employed steadily on the photographing of faint variable stars in the Milky Way.

A JUNIOR NOBEL AWARD

THE stimulation of research by engineers under thirty years of age is the main purpose of the Alfred Nobel prize granted this year for the first time in honor of the illustrious civil engineer. The prize-winning paper, "Arsenic Elimination in the Reverberatory Refining of Native Copper," is the production of Mr. Corbin T. Eddy, assistant professor of metallurgy at the Michigan College of Mining and Technology, who has conducted most of the first part of that institution's research into the copper-cuprous oxide system, with the ultimate aim of evaluating various methods of eliminating from native copper such impurities as arsenic, silver, iron and oxygen, and of formulating more precisely than has yet been done the effect of each impurity on the physical properties of copper. Study of the copper-silver system, the second step of the program, has begun under the general direction of Professor A. T. Sweet, department chairman, with Professor Eddy, Professor Drier and Research Engineer Tolonen participating.

The process of copper elimination analyzed in the prize-winning article, which was delivered before the 1931 meeting of the American Institute of Mining and Metallurgical Engineers, was for decades an unregarded method, until revived by Michigan copper men some years ago. It is the method now regularly used by them in the reverberatory refining of native copper.

Papers eligible for the award included all those written by men under thirty years of age which were published in the journals or transactions of the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Western Society of Engineers and other similar organizations. The offering of this junior award is intended to stimulate the increasing production of reports which are both theoretically sound and also valuable to key industries.

SCIENTIFIC NOTES AND NEWS

AT the opening meeting of the autumn session of the National Academy of Sciences at Yale University on November 16 the address of welcome will be given by Dr. James Rowland Angell, president of the university. The response will be made by Dr. William Wallace Campbell, president of the academy. A public lecture on the evening of November 16 will be given by Dr. John Campbell Merriam, president of the Carnegie Institution of Washington, whose subject will be "The Cats of Rancho La Brea; a Climax to Evolution."

DR. WALTER B. CANNON, Higginson professor of physiology at Harvard University, on behalf of the faculty of medicine, and Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, on behalf of the faculty of science, were awarded the honorary doctorate of the University of Paris at the opening ceremonies held in the Sorbonne on November 7.

DR. C. D. PERRINE, formerly of the Lick Observatory and for the past twenty years director of the National Observatory of Argentina at Cordoba, has been elected a corresponding member of the Sociedad Cientifica Argentina of Buenos Aires.

SIR SIDNEY HARMER, lately director of the natural history departments of the British Museum, has been elected a foreign member of the Royal Swedish Academy of Science.

AT the inauguration of the new president of Morningside College, Sioux City, Iowa, on October 24, honorary degrees were conferred upon four of its early graduates, including Dr. Fred J. Seaver, curator of the New York Botanical Garden, and Dr. Alexander G. Ruthven, formerly professor of zoology and director of the museum and now president of the University of Michigan.

DR. SAMUEL NEWTON SPRING, professor of silviculture in the department of forestry at Cornell University, has been appointed assistant dean of the New York State College of Forestry at Syracuse University. Professor Spring will assume his duties as assistant dean and director of instruction for both the college and the New York State Ranger School early in 1932.

DR. HENRY ALDEN SHAW has been appointed assistant professor of mental hygiene at the Harvard University Medical School. He has been associated with the school since 1925 as assistant in hygiene and psychiatrist.

DR. MARVIN L. PABST, formerly an instructor in the division of pharmacology, College of Medicine, University of Tennessee, has been appointed assistant professor of pharmacology in the University of Buffalo College of Pharmacy.

DR. FRED O'FLAHERTY, of the research staff of the University of Cincinnati, has been appointed director of the research laboratory of the Tanners' Council of America.

THE British Ministry of Agriculture and Fisheries has appointed Mr. J. L. S. Gilmour, curator of the University of Cambridge Herbarium and Museum, of the Botany School, to be assistant director of the Royal Botanic Gardens, Kew.

THE faculty board of biology at the University of Cambridge has appointed Mr. A. G. Brighton, of Christ's College, curator of the Sedgwick Museum of Geology for three years, dating from October 1.

DR. G. H. HARDY, Sadleirian professor of pure mathematics in the University of Cambridge, has been elected to a professorial fellowship at Trinity College. Dr. Cecil Edgar Tilley, professor of mineralogy and petrology, has been elected to a similar fellowship at Emmanuel College.

THE Soviet Government has granted to Professor Ivan Pavlov an appropriation of 184,000 roubles to complete the building of his biological station at Koltouchi, near Leningrad.

PRESIDENT HOOVER has announced the appointment of Colonel Charles A. Lindbergh to be a member of the National Advisory Committee for Aeronautics.

DR. PERCY E. RAYMOND, professor of paleontology at Harvard University, has returned from England, where he was a delegate from the Geological Society of America to the centenary meeting of the British Association for the Advancement of Science.

DR. OTTO SCHMIDT, German dye chemist and director of the Farbenindustrie Aktiengesellschaft, which is the German chemical trust, has arrived at the California Institute of Technology for a stay of three months, during which he will consult with leading American chemists. Dr. Schmidt will later visit industrial centers.

DR. A. E. GEE, who has spent two years at the University of California Scripps Institution of Oceanography in research on bacteriology, has left for his home in Canada.

DR. JAMES EWING, professor of pathology at the Cornell Medical College, delivered the annual discourse at the New York Academy of Medicine on November 5. His subject was "The University and the Medical Profession."

THE twenty-eighth Hanna lecture of the Western Reserve University Medical School will be given by Dr. E. D. Adrian, fellow of Trinity College, Cambridge, and Foulerton research professor of the Royal Society, London. Professor Adrian will give an illustrated lecture entitled "The Nervous Mechanism of Sensation and Movement."

COLONEL GEORGE A. SKINNER, of the medical corps of the U. S. Army, gave at the Mayo Institute a Mayo Foundation lecture on October 27. His subject was "Early Experiences in Tropical Medicine."

DR. CARL G. HARTMAN, of the department of embryology of the Carnegie Institution of Washington, showed a movie film on the "Parturition in a Monkey," at the recent meeting of the Central Association of Obstetricians and Gynecologists, before which he also made an address on "Ovulation in Man and Monkey." The film has also been exhibited to the German Medical Society of New York City.

THE inaugural lecture of the chair of anatomy at the University of Edinburgh was delivered on October 6 by Professor James Couper Brash, who has been elected to the chair of anatomy in succession to Professor Arthur Robinson, retired. Professor Sydney Smith, dean of the faculty of medicine, presided.

THE first public lecture under the Estlin Carpenter Educational Trust was given at Oxford by Sir Peter Chalmers Mitchell on October 13. His subject was "Life and Matter."

SIGMA PI SIGMA, honorary physics fraternity, held its convention at the University of Kentucky from November 5 to 7. Dr. W. F. G. Swann, director of the Bartol Research Foundation, gave the principal address.

THE U. S. Civil Service Commission announces that the position of principal physiological chemist at a beginning salary of from $5,600 to $6,400 a year is open for competitive examination. The examination is to fill a vacancy in the bureau of construction and repair, Navy Yard, Washington, D. C., and vacancies occurring elsewhere, for duty in Washington, D. C., or in the field. Applications must be on file with the U. S. Civil Service Commission at Washington not later than December 1, 1931.

ON October 17 and 18 a group of physiologists were guests at the Morris Biological Farm. They met in response to a resolution passed at a meeting of physiologists and others held on August 12 at the Marine Biological Laboratory, in Woods Hole, to consider the question of organizing a new journal of physiology intended to supplement those already existing and to relieve certain other journals, not devoted primarily to physiological subjects, of papers which take space intended for zoological or anatomical matter. Those in attendance were as follows: Dr. E. N. Harvey, of Princeton University; Dr. M. H. Jacobs, of the University of Pennsylvania; Dr. E. K. Marshall, of the Johns Hopkins University; Dr. G. H. Parker, of Harvard University; Dr. A. C. Redfield, of Harvard University, and Dr. H. W. Smith, of New York University. The field to be covered by the journal was fully discussed, and a title and outline of its purposes were tentatively agreed upon. Dr. E. N. Harvey, of Princeton University, was selected as the managing editor, and certain other names were suggested as desirable members of the editorial board.

SIXTY-FIVE years ago A. Léotaud, an eminent ornithologist in Trinidad, completed his collection of birds on that island off the coast of Venezuela, and it was later installed in the Victoria Museum in Port of Spain. When this museum burned a few years ago all these specimens were destroyed, including several whose existence since has been doubted because recent collectors had not found similar species. Now, according to an announcement made by the Academy of Natural Sciences, Philadelphia, an expedition, comprising W. Wedgwood Bowen, assistant curator of birds in its department of vertebrate zoology, H. Radclyffe Roberts, of Villa Nova, and George R. Clark, of Cynwyd, has returned from a two-months stay in Trinidad with the most representative collection made since Léotaud's, and containing some of the disputed species, thus verifying his records.

THE University of Pittsburgh chapter of Sigma Xi announces the following series of public lectures on the culture of prehistoric man: November 18, "The Art of Paleolithic and Neolithic Man," by Dr. Andrey Avinoff, director of the Carnegie Museum of Pittsburgh; January 27, "Man, the Speaking Animal," by Dr. Melville Jean Herskovits, assistant professor of anthropology at Northwestern University; March 16, "The Origin and Development of Tools and Weapons," by Dr. Nels Christian Nelson, curator of prehistoric archeology at the American Museum of Natural History, New York City.

THE thirty-third annual meeting (the one hundred and seventy-fifth regular meeting) of the American Physical Society will be held in New Orleans at Tulane University, on December 29 and 30, in affiliation with Section B—Physics—of the American Association for the Advancement of Science. The preliminary arrangements for the New Orleans program include joint sessions with the American Mathematical Society on Tuesday morning and afternoon, with addresses by Dr. W. F. G. Swann, Professor G. D. Birkhoff and Professor G. A. Bliss, including the

Josiah Willard Gibbs lecture by Dr. P. W. Bridgman. On Wednesday morning there will be a joint session with Section B of the American Association for the Advancement of Science with the address of the retiring vice-president of Section B, Professor F. K. Richtmyer, and an address by Dr. H. H. Kimball. On Wednesday afternoon there will be a joint session with Section E of the association and the Society of Petroleum Geophysicists for a geophysical program.

ACCORDING to an announcement in *Nature* the Ninth International Congress of the History of Medicine will be held at Bucharest, under the presidency of Dr. V. Gomoiu, next September, when the principal subjects for discussion will be (1) the evolution of medicine in the Balkan States and (2) the protection of Europe against bubonic plague. Those wishing to contribute papers on these or other subjects are requested to forward the title and a typed copy of a summary of their paper to the office of the Congress, Str. Stirbey Voda 86, Bucharest II, without delay. The official languages will be English, French, German, Italian and Spanish. Members of the congress can take the direct route to Bucharest or meet at Trieste, whence visits will be paid to Athens, Constantinople and Constantza, where local committees will be arranged for their reception. The meetings of the congress will occupy four days, and the following three days will be devoted to a tour of Bucharest and excursions in the neighborhood. A program will be issued later, giving the exact date of the congress and the amount of the subscriptions.

Nature reports that the twenty-second annual exhibition of electrical, optical and other physical apparatus is to be held by the Physical Society and the Optical Society from January 5 to 7, 1932, at the Imperial College of Science and Technology, South Kensington. The trade section will comprise the exhibits of manufacturing firms. The research and experimental section will be arranged in two groups: (*a*) exhibits illustrating the results of recent physical research; (*b*) lecture experiments in physics. The exhibition committee invites offers, from research laboratories and institutions and from individual research workers, of exhibits suitable for inclusion in either of the above groups. Offers of exhibits, giving particulars of space and other facilities required, should be communicated immediately, and in any case not later than November 9, to the secretary of the exhibition committee, 1 Lowther Gardens, Exhibition Road, London, S.W.7. The section for apprentices and learners has for its object the encouragement of craftsmanship and draughtsmanship in the scientific instrument trades. Apprentices and learners may exhibit, in competition, specimens of their work, providing they are in the regular employ of a firm which is exhibiting at the next annual exhibition, or has exhibited once during the past three years. Printed particulars of this section will be sent on application to the secretary.

DISCUSSION

CONCERNING AN INCREASE IN THE POTENCY OF MOSAIC VIRUS IN VITRO

IN an earlier paper one of us (O.)[1] published results of experiments which indicated that multiplication of the virus of tomato and tobacco disease had taken place in the absence of living cells. The work of J. Henderson Smith[2] and others cited by him has not been confirmatory of these results, and hence the subject has been studied anew.

About 3,000 tomato plants (with several thousand as controls) were utilized in a series of 30 experiments. In 6 of them the original technique was followed as closely as possible. In 24 the conditions were altered considerably. The hydrogen-ion concentration of the media was kept constant by diluting one part of filtered fresh normal plant juice with 2.5 parts of Northrop's buffer[3] at pH = 5.3, and the tests were made under aerobic or anaerobic conditions, in the dark or sunlight. Fifteen experiments were carried out with Gates' U tubes,[4] according to the method of Muckenfuss and Rivers[5] with vaccine virus. A collodion sac containing fresh, lightly crushed, young plants in buffer solution was inserted in one arm of the tube and buffer solution containing filtered virus was placed outside the sac. The medium within the sac was replaced from one to seven times weekly. The tubes were kept at 28° C.

Almost always, irrespective of the method employed, there was some increase in the potency of the virus beyond the original titration. An increase has also been noted by McKinney.[6] In the early experiments it was much greater than in the later ones, for reasons as yet not clear. There may conceivably be some cyclic variation in the virus. The question arises of whether the increase was due to an activation, or a

[1] P. K. Olitsky, *J. Exp. Med.*, 41: 129, 1925.
[2] J. H. Smith, *Ann. Applied Biol.*, 15: 155, 1928.
[3] J. H. Northrop and P. H. de Kruif, *J. Gen. Physiol.*, 4: 639, 1922.
[4] F. L. Gates, *J. Exp. Med.*, 35: 635, 1922.
[5] R. S. Muckenfuss and T. M. Rivers, *J. Exp. Med.*, 51: 149, 1930.
[6] H. H. McKinney, *J. Agric. Res.*, 35: 1, 1927.

dispersion of aggregated virus particles, by a mechanism as yet not understood, or whether it represented actual multiplication of a living agent. The same problem has arisen in connection with the increase in potency of vaccine virus in a lifeless medium.

In view of the outcome of the experiments, we have concluded that the results of our tests can not with certainty be referred to a true multiplication of the mosaic virus.

PETER K. OLITSKY
FILIP C. FORSBECK

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK, N. Y.

GEOMORPHOLOGICAL EVIDENCE OF A CLIMATIC BOUNDARY

ONE of the most significant climatic boundaries across the United States separates the territory experiencing effective winter cold from warmer regions on the south. Within humid climates the northern region is often called the cool temperate and the southern, warm temperate climate. In the terminology of the Köppen[1] system of climatology the two are designated microthermal and mesothermal, respectively. Within the realm of the dry climates the distinction becomes that between hot and cold steppes and deserts.

In a recent paper the writer[2] has presented arguments in favor of using one and the same boundary whether climates are humid or arid and has suggested that in the United States the January isotherm of 32° F. appears more satisfactory than any other proposal thus far made.[3] Certain contrasts were pointed out in vegetational, soil, geomorphological and cultural forms on the two sides of that isotherm. Since the publication of that paper he has observed a very interesting and fundamental condition that lends additional support in favor of the January 32° F. thesis.

The January isotherm of 32° F. enters the Atlantic Seaboard approximately at New York City, swings southward through New Jersey and across the Appalachian region, west of which it approximates the positions of the Ohio and Missouri rivers as far as the eastern boundary of the dry climates

[1] W. Köppen, "Die Klimate der Erde" (Berlin, W. de Gruyter Co., 1923).

[2] R. J. Russell, "Dry Climates of the United States: I, Climatic Map," *Univ. Calif. Publ. Geog.*, 5: 1–41, 1931.

[3] W. Köppen (1923) uses the mean annual isotherm of 18° C. (64.4° F.) in dry climates and the January isotherm of −3° C. (26.6° F.) in humid climates. On the more recent Köppen-Geiger "Klimakarte der Erde" (1: 20,000,000), (Gotha, Justus Perthes, 1928), he uses the value of eight or more months above 1° C. (33.8° F.) in humid climates. Van Royen, *Monthly Weather Review*, 55: 319 (1927) suggests, for the dry climates, the cold month isotherm of 50° F.

In the Trenton Folio of the United States Geological Survey Florence Bascom[4] calls attention to the fact that in the Coastal Plain of New Jersey topography sloping toward the north is notably steeper than that toward the south. The writer is not only able to confirm this observation but finds that it applies with equal force in landscapes of southern Ohio. South of both of these regions it disappears, thus appearing to be related to the position of the January 32° F. isotherm both east and west of the Appalachians.

In both cases the nature of the underlying bedrock is such that it could not possibly account for the observed slope asymmetry, as it is very nearly flat-lying. It is obvious that the details of sculpture must be ascribed to denudational processes now taking place.

While contrasted angles of incidence of sunlight on north and south slopes condition processes of weathering, evaporation rates, vegetational cover, and other denudational elements, it seems apparent that the greatest single effect is with reference to snow cover. On the borderlands of the region effectively blanketed by snow for considerable periods during the winter months, slight differences in slope direction produce enormous contrasts in the length of time snow actually remains on the ground. The relatively sunny southward slopes are barren for long periods during which northward slopes lie beneath thin sheets of snow. The snow protects the ground beneath from denudation during much of the critical winter period. Thus a contrast arises in the rate at which denudation takes place on the banks of any rills or streams flowing in directions approaching east or west. The northern bank, being the more rapidly attacked, has its gradient lessened in comparison to the southern bank, hence arises the topographic contrasts observed.

It is notable that in the southeastern United States erosion and denudation take place very rapidly, particularly as the result of the absence of frozen soil or snow cover during the winter season of vegetational dormancy, whereas in the northeastern and north central regions these processes are comparatively slow. Agricultural occupation aggravates conditions to such an extent that the loss of soil from the fields of the southern states has become recognized as a major national problem, and one recently receiving much attention as a result of the studies of H. H. Bennett and others. From the standpoint of climatology the contrasted regions may be considered mesothermal and microthermal climates.

Recognizing that all climatic boundaries are attempts to indicate mean positions within zones of gradual change, the asymmetrical slopes of New Jer-

[4] Folio 167: 2, (1909).

sey and southern Ohio have unusual interest in respect to the climatic boundary under consideration. The snow-covered northward slopes are effectively microthermal as regards snow cover and the southward slopes are mesothermal. Thus, from the geomorphological standpoint, in the vicinity of the isotherm of January 32° F., we find an ideal expression of climatic borderline conditions, innumerable islands of one climate within the realm of another. Whereas climatic contrasts may take place within comparatively short distances in areas of considerable relief, it is unusual to find them so strikingly displayed in such comparatively flat regions as those under discussion and hence of all the greater significance.

RICHARD JOEL RUSSELL
LOUISIANA STATE UNIVERSITY

CHLORATES AS HERBICIDES

THE persistent spread of the more noxious perennial weeds has recently focused the attention of many experimental workers on the problem of a cheap, safe and effective chemical method for the eradication of these plants. Sodium chlorate has proved in many trials to be the most generally effective herbicide now in use. With proper methods, such weeds as Canada thistle (*Cirsium arvense*), European bindweed (*Convolvulus arvensis*), quack grass (*Agropyron repens*) and similar plants can be controlled with one or more applications of this chemical. The cost ranges from twenty-five to one hundred dollars an acre and the fire hazard may be very serious with the usual methods of application in which a chlorate spray is applied to a heavy growth of foliage.

A three-year study of the herbicidal action of sodium chlorate in the botany department of the Iowa State College indicates that this compound may be more effective when applied to the roots rather than to the aerial portions of the plant, and suggests that under humid conditions the elimination of perennial plants by spraying with chlorates is dependent upon a portion of the spray residue reaching the soil. By applying the chemical, either crystalline or in solution, directly to the moist soil it is possible to reduce the quantities applied, and if the top growth of the plants is removed before treating, the principal fire hazard is eliminated. The apparently unchanged chlorate salt persists in the soil for a period varying with the conditions from a few weeks to two or more years. The herbicidal action consists of both a direct killing of the underground portions of the plants and of translocation to and slow killing of any new sprouts which may be formed. The importance of the two effects probably varies with the plant and the conditions. Quack grass or Canada thistle rhizomes and roots may be killed in the dormant stage, so that the effects of ultra-violet light are not required for the toxic action of chlorates. We have been unable to obtain any appreciable translocation of the toxin except in the transpiration stream, and any generalized action seems to be dependent upon the ability of the salt to persist in the soil solution, where, as stated, it may either penetrate and kill the roots and rhizomes, or be absorbed and translocated to transpiring regions of the top. The continued killing of the tops adds starvation to the direct action on the underground organs and explains the effectiveness of the treatment.

The tendency of the chlorate to persist in the soil may become seriously objectionable under some conditions. In our field tests we find that heavy applications which result in a large quantity of the salt reaching the sub-soil are particularly persistent. Temperature and leaching seem to be the most important factors concerned in the disappearance of chlorates. At temperatures of 25 to 30° C. treated soil loses its toxic properties in a few weeks, while in the sub-soils mentioned (three to five feet) the chlorate concentration is still too high to permit crop growth nearly two years after the initial application. The surface foot of these same plots which received chlorate at the rate of 1,000 pounds per acre is normal. The use of lighter applications under more favorable conditions should reduce the deep penetration and persistence of chlorates.

The recognition of the fact that chlorates are effective when used as root absorption poisons will permit the use of the sodium salt instead of the more expensive calcium chlorate. It will make it possible to eliminate the fire danger, now a very serious factor, avoid the destruction of chlorates exposed on the leaves of sprayed plants and help to reduce the after-effects of chlorate applications by avoiding excessive applications in cool soils not subject to leaching.

W. E. LOOMIS
RUSSELL BISSEY
E. V. SMITH

DEPARTMENT OF BOTANY,
IOWA STATE COLLEGE

THE CAUSATIVE ORGANISM OF A PAPULAR TYPE OF APPLE MEASLES[1]

THE disease known as apple measles, reported first by Hewitt and Truax[2] in 1912 as an obscure apple disease, has recently attracted especial attention in certain sections. This disease has been reported under various names which include "measles," "pimple

[1] Approved by the director of the West Virginia Agricultural Experiment Station, as Scientific Paper No. 97.

[2] J. L. Hewitt and H. E. Truax, "An Unknown Apple Tree Disease," Arkansas Agric. Exp. Sta. Bull. 112: 481–491, 14 figs, 1912.

canker," and "scurfy canker." Previous investigators have considered it to be of a non-parasitic nature and of minor importance. It has been stated that it does not cause the death of the trees affected. This opinion, however, has been considerably modified as a result of recent investigations. The writer's studies seem to indicate that the various forms of measles hitherto described are not all manifestations of the same causative agent but are distinct diseases. One of these types of measles, a papular form, briefly reported here, has been proven to be caused by a parasitic fungus.

The disease first came to the attention of the writer in 1915, in the course of the application of an orchard dusting program in the Kanawha Valley, north of Charleston, West Virginia. Measles at that time was confined to a few Red Astrachan trees. The trunks and larger limbs presented a peculiar scurfy appearance while the younger twigs, especially the water sprouts, were covered with small, well-defined papules. Attempts to isolate an organism from these papules always resulted in sterile plates. Subsequent attempts in later years yielded the same results.

Frequent visits to this orchard each season, since the disease was first observed, have enabled the writer to observe its spread from the Astrachans, which constitute only a very small percentage of the planting, to Rome, the predominating variety. Interplantings of Gano, Transparent, Chenango, Pound Royal and Summer Queen, remained free from measles. Two years ago the orchard was abandoned because the disease had practically killed 16,000 trees. In the meantime numerous specimens of apple twigs affected with this type of measles have been obtained from adjoining counties in central and southern West Virginia.

In 1929, an active study of the disease was undertaken at this station. The work was conducted in the Kanawha orchard, where the papular type of measles was most prevalent. Small Red Astrachan and Stark's Delicious trees were planted near large Red Astrachan trees infected with measles. Both varieties became heavily infected with the papular form the first season. Attempts to isolate the causal organism again ended in failure. In 1930, the writer was stationed in the orchard throughout the growing season in order to keep the development of the disease under close and constant observation. However, due to the unprecedented drought very little infection took place. A few rains occurred late in the summer and a total of only 44 papules of new infection were located in the entire orchard, all on Red Astrachan, which seems to be the variety most susceptible to this form of measles. *Thirty-four of these yielded pure cultures of a peculiar, slow-growing fungus.* Sporulation of this fungus can be obtained by growing it on oatmeal or malt-extract agar.

Successful artificial inoculations were obtained on young Red Astrachan trees in the greenhouse during the past winter and the fungus was readily reisolated from the lesions produced. Diseased apple twigs collected in the Kanawha orchard on June 20, 1931, were placed in a moist chamber for 24 hours. Spores were obtained by scraping the surface of the older lesions. By studying free-hand sections of the diseased spots it was found that the fungus is a *Hyphomycete* and apparently belongs to the genus *Clasterosporium*, the species being yet undetermined.

ANTHONY BERG

WEST VIRGINIA UNIVERSITY,
MORGANTOWN, WEST VIRGINIA

BIOLOGICAL ABSTRACTS—A DISCUSSION

THE value of such a comprehensive abstracting system as Biological Abstracts is well recognized by all workers in biological sciences, and is very well summarized in several articles published recently in SCIENCE.[1] In spite of the value of such a journal to subscribers, there are certain admitted drawbacks to it among which are the delay in publication, the cost of such an undertaking, and the time consumed by 6,000 abstractors and one hundred or more editors. If this were a temporary matter we might all be willing to help by personal effort or subscription, but it is a perpetual matter and as already shown will demand more time, effort and money as the years go by. It would therefore appear worthwhile to see if some method could not be devised to simplify this enormous undertaking.

As I understand the present system used by Biological Abstracts, an editorial and clerical staff first reviews the entire biological literature of 55,000 articles (yearly), and then decides who should abstract each of these articles (55,000 decisions). The well-known yellow abstract requests must then be mailed, asking for abstracts (55,000 letters). Many of these need second requests, inquiries, change of abstractor, etc. After this 6,000 men and women abstract these 55,000 articles which if done conscientiously is a difficult and tedious matter; many of us have seen young men struggling over an article in a foreign language which they very imperfectly understand. After these abstracts are made they are mailed to Biological Abstracts, who then collect, and remail to section editors, who in turn edit these collected abstracts in their field and return to Biological Abstracts where they are finally printed. Such a procedure is

[1] W. C. Curtis, SCIENCE 73: 1898, 509, 1931; J. R. Schramm, SCIENCE 73: 1898, 512, 1931; C. E. McClung, SCIENCE 73: 1898, 517, 1931; F. R. Lillie, SCIENCE 73: 1899, 560, 1931.

obviously complicated, expensive, time consuming and needs besides the voluntary support of some 7,000 men yearly, an additional aid at present of more than $100,000, all of which will have to be increased in the future. Considering that Biological Abstracts is not a personal undertaking, but a program of interest to all biologists let us see whether there is any other practical alternative to the present method.

Let us consider a plan of obtaining the cooperation of all editors of biological journals in requiring that an abstract of each article be submitted by the author with the original manuscript (as is already the case in certain journals). Assuming for a moment that such a plan could be put in force, every article of biological nature would be abstracted even before publication. When an editor had a number of his journal made up, these abstracts could be simply mailed to Biological Abstracts and published at once. In this way there would be no delay in the appearance of abstracts. Authors would receive immediate recognition of their work. Investigators could obtain an immediate review of all biological literature, and several thousand voluntary abstractors and section editors would be relieved of their constant non-remunerative drudgery. The paid editorial and clerical staff as well as general expenses could be greatly reduced.

The first and almost unanimous comment obtained regarding such a plan from those whom I have consulted during the past four or five years is that "It will not work." This has however been said of many successful undertakings. The advantages of such a plan are obvious, and have been granted by numerous abstractors, section editors, editors of biological journals, and several of the best librarians of the country. Let us consider the possibilities of carrying out such a plan and some of the criticisms which have been raised.

(1) It is said that the editors of biological journals could not or would not obtain these author abstracts. It is probable that only a small percentage of these editors would agree to such a plan at first, but if the plan were supported by an influential group of editors, and their acceptance of it brought to the attention of others, many more would fall in line.

(2) The comment has been made that authors would not submit abstracts. This could be very simply taken care of by editors refusing to publish manuscripts not accompanied by abstracts.

(3) Another criticism is that authors are often unable to abstract clearly and concisely. This may equally well be said of voluntary abstractors. What is wanted in an abstract is the main points of the work stated correctly, not a critical review. Certainly authors should be able to do this more intelligently than anyone else.

Finally let us consider practical ways in which such a plan might be carried out. Obviously the editors of Biological Abstracts do not wish to be burdened with further projects. The success of such a plan as outlined, lies with the editors of the various biological journals. It is felt that the most likely way to interest them in adopting such a method would be for all authors, abstractors, section editors, etc., to write to the editors of those journals in which they are particularly interested, expressing their opinion of such a plan. Biological Abstracts could be helped directly by any editor guaranteeing them abstracts of his journal. If a few editors should adopt the system others might fall in line and gradually such a plan might be universally adopted. The author would be glad to receive any comments on this proposed plan or word from any editor putting such a plan in force in his journal, and to report at a later day any progress made.

PAUL D. LAMSON
DEPARTMENT OF PHARMACOLOGY,
VANDERBILT UNIVERSITY SCHOOL
OF MEDICINE,
NASHVILLE, TENNESSEE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ADAPTATION OF THE BOX CAMERA TO PHOTOMICROGRAPHY

A BOX camera can be converted into a photomicrographic camera suitable for general routine work with a few minor changes. The camera used should be of metal construction and must have a removable front. Any of the Eastman Kodak Brownie cameras will serve the purpose though the larger models are to be preferred.

The first adjustment is to remove the front of the camera and enlarge the central aperture therein. Pry off the ferrule from about the hole and enlarge the hole with a round file until it will just admit the threaded portion of the eye lens of an ocular. Insert the eye lens into the hole from the inside surface of the front plate and screw the ocular tube in place, thus enclosing the camera front between the eye lens and tube of the ocular. Next remove the lens and shutter block from the camera, take out the lens and return the block to its former position.

To make the focusing apparatus, a tube of brass or stout cardboard between $\frac{3}{8}$" and $\frac{7}{8}$" in diameter is cut to a length ascertained as follows; remove the back of the camera and cut a piece of glass just large

enough to rest upon the rollers that support the film and upon nothing else. Mark an X with a wax pencil in the center of this glass sheet and bring a tripod magnifier (Bausch and Lomb 7.5X or other suitable lens) to focus through the glass on the X. (Be sure you focus through the glass.) Now place the glass sheet and the magnifier upon the camera with the X towards the inside of the camera, insert the ocular with its attached camera front into the microscope, place the camera upon its front on the microscope and measure the distance from the upper surface of the metal mount of the ocular eye lens to the X on the under surface of the glass and from the under surface of the glass to the under surface of the lens of the magnifier. Cut the tube in length corresponding to the sum of these two dimensions.

In using the camera it is loaded with film in the usual manner, the front plate is attached to a suitable ocular, the ocular placed in the microscope and the focusing tube placed upon the upper surface of the ocular. The tube is then surmounted by the same magnifier as previously used and the image is brought to focus through this assembly. When the focus is as sharp as possible remove the tube and magnifier and carefully place the camera over the ocular and upon its front. Turn off the light source or place a cardboard between it and the microscope, set the shutter for time and open it, turn on the light for the required length of time, turn off the light, close the shutter.

One warning is here necessary. Be very sure that the coarse adjustment of the microscope is tight enough to support the camera without putting the image out of focus.

Though the modern roll film box camera is here used as an example there is no reason why some of the older model plate and film pack boxes or some of the newer foreign film pack boxes can not be suitably converted into photomicrographic cameras. The advantages of plates and film packs in photomicrography is unquestionable.

Finally, any photomicrographic camera, in order to record the image at the same magnification that the eye sees it, must afford at least ten inches of space between the ocular and the plate or film. Since the box camera is much shorter than ten inches due allowance must be made in the magnification of the microscope in order to obtain the desired results.

CHARLES S. APGAR
WISTAR INSTITUTE OF ANATOMY

A METHOD FOR THE PRESERVATION OF OLD MANUSCRIPTS

AN entirely satisfactory method of preserving old manuscripts does not appear to be known. Particularly desirable is one for preserving old letters and similar material, which can be cheaply and readily prepared and which can be used by any one with fair manual dexterity, but without requiring special expert knowledge of physics, chemistry or paper technology. The method here discussed has been tested with gratifying results.

PROCEDURE

A mixture of equal volumes of carbon tetrachloride and benzene is prepared and kept in a tightly stoppered bottle. The mixture is not explosive, but benzene vapor is, so reasonable precautions should be observed. As this mixture is an excellent solvent for fats, care should be taken to keep from contact with the worker's skin and to anoint the place of any contact with the person with olive oil, cold cream or some fatty ointment.

To 100 cubic centimeters of the solvent mixture is added 30 to 35 grams of a good hard wax. This solution is equivalent to one of a pint of the mixed solvent to five or six ounces of wax. In our experiment good results were obtained with the commercial product known as halowax number 1,013, with a melting point of 248° F. Oven tests of news print and other papers treated with this wax showed it would not run or stick at any summer temperature imaginable.

Most conveniently the wax is applied by pouring the solution into a shallow pan or dish, such as a photographer's developing trap. The paper is immersed, care exercised that it be completely wetted and any bubbles formed on either side be removed. The paper is then drained by holding it vertically and turning from time to time to prevent undue deposit of wax at an edge.

An alternative method is to apply the wax solution to the paper with the camel's-hair brush. But the immersion procedure has been found more desirable.

When drainage ceases, the treated paper is dried. Oven drying is practicable but air drying seems preferable. To this end the treated paper is laid upon a smooth surface on blotting paper (when practicable) and exposed until the odor of neither benzene nor carbon tetrachloride can be detected longer. When dry, if too much wax appears in places on the surface of the paper it may be smoothed over with the camel's-hair brush moistened with the solvent.

DISCUSSION

Manuscripts so treated are protected from atmospheric action. The paper always seems to be strengthened and very fragile pieces become susceptible of safe handling if careful. Breaks in the wax film, due

to bending or impact for instance, can be readily replaced by brushing with the dissolved wax or with the solvent.

The softer waxes generally impart a yellowish or brownish color, are prone to stick but are more pliable and being amorphous give a better protection from attack by air or moisture. The harder waxes, such as the above noted, impart no color, do not stick even under considerable pressure and rather high temperatures. They are more apt to yield cracks or breaks under rough handling. On standing, as can be observed under a microscope, the whole film tends to crystallize into a matter mass. It is reasonable to infer that such a film can not give as good protection from the atmospheric attacks as the softer films. Perhaps a satisfactory compromise may be obtained by mixing two or more waxes. Our experiments, however, favor the use of a hard wax as stated.

Due to the rapid evaporation of the carbon tetrachloride and benzene, the solutions become more concentrated when allowed to stand in the air. For this reason the solution should never be allowed to stand in the open except when being used. If the solution becomes too concentrated more of the carbon tetrachloride-benzene mixture should be added. If a hydrometer is at hand, it is a good idea to take the specific gravity of the solution at the beginning and on evaporation of the solvent more of it should be added to bring the specific gravity down to that of the initial solution.

If previous cleaning of the manuscripts is desirable, the procedure described by J. C. Fitzpatrick is suggested.[1] After waxing the manuscript can be conveniently cleaned or washed, although care should be exercised to carefully remove any excess water, especially when hard wax has been used.

No ink has yet been encountered which dissolves or "runs" in the wax or the solution, and the dried film produces no appreciable diminution of legibility.

The fire hazard is generally decreased by the wax. Treatment with insecticides, fungicides or even rodent repellents is not made more difficult. In fact, the use of some of these may be facilitated by dissolving them in the wax solvent.

Further work with protecting films is in progress. The easy application and apparently great usefulness of the procedure described impels us to call it to immediate notice of interested parties.

The halowax used was obtained from Halowax Corporation, 247 Park Avenue, New York City.

J. P. SANDERS
F. K. CAMERON

CHAPEL HILL, N. C.

[1] "Notes on the Care, Cataloging, Calendaring, and Arranging of Manuscripts," 3rd Edition, U. S. Government Printing Office, 1928.

THE USE OF LIVE NEMAS (METONCHOLAIMUS PRISTIURUS) IN ZOOLOGICAL COURSES IN SCHOOLS AND COLLEGES

ANSWERING very numerous requests for a free-living nema suitable for school and college class work, attention is called to *Metoncholaimus pristiurus*, a slender, five-millimeter species common in European and North American stagnant marine mud, below low tide—for example, in the harbors at Woods Hole, Massachusetts, and Naples, Italy—a nema suitable for study alive with moderate and high powers of the microscope. It is a well-differentiated, bisexual nema that can be sent by post or express long distances in a living condition, and there seems no reason why the usual collecting agencies should not supply it alive to any inland laboratory at moderate cost. It withstands journeys of thousands of miles; *e.g.*, it has been successfully shipped (both summer and winter) from Woods Hole, Mass., to Washington, D. C.; Durham, N. C.; and Salt Lake City, Utah; and successfully used in class work. One laboratory director reports a "very interesting and exciting two-hour period."

This nema may be ordered from the Supply Department of the Marine Biological Laboratory at Woods Hole, Massachusetts, and no doubt could be supplied from Naples, and many other harbors. Laboratory instructors will find readiest guidance to the anatomy, etc., of this and very similar nemas in *Jour. Washington Acad. Sci.*, vol. 20, No. 12, 1930. Experienced nematologists consider free-living marine nemas the best teaching material for entrance to nematology. *Metoncholaimus pristiurus* belongs to a large marine group, the *Oncholaiminae*—type genus *Oncholaimus*,—abundant in all oceans, and hence may perhaps be considered as nearly "a representative species" as one is likely to obtain from such an immense and varied phylum.

(1) *Collecting.* *Metoncholaimus pristiurus* may be successfully dredged with a metallic, one to two-liter cylindrical vessel, one to two decimeters in diameter and two to three kilograms in weight, cast several yards from shore, allowed to sink to the bottom, and slowly pulled in by means of 25 meters of ⅜ inch limber rope, firmly linked at a single point on its rim. This dredge, cheaply made from iron pipe, should sink through any bottom growth of eel-grass, etc., so as afterward to bite into the top layer of mud in which the oncholaims live.

M. pristiurus is about the largest nema in its native mud, and hence is readily assembled for shipment, with the aid of appropriate sieves (1st, 1/8 inch mesh to remove coarse débris; 2nd, 1/24 inch mesh to catch the nemas while permitting silt to pass through). Preferably the nemas should defecate in clean, cool sea water for a day or two before examination, since

at the time of collection they may contain considerable ingested mud that would interfere somewhat with the microscopic examination—although the nemas can be profitably examined immediately on collecting.

It is very important to the student of nemas that he *study living material.* For examination alive, *M. pristiurus* may be placed in a drop of tap water for from 10 to 60 seconds until it quiets down, and then mounted at once in a droplet of clear sea water under a thin cover-glass with sufficient pressure to keep the nema from moving more than a very little. This pressure can be applied by drawing the extra sea water from under the round cover-glass with a sliver of filter-paper until the nema can barely move, and then sealing in at once on a turntable with a modicum of smoking hot wax (formula, 1 of beeswax plus 3 of 45° paraffin), best applied from the wick of an ignited, narrow 5-millimeter-gauge taper made of the wax, somewhat like a Christmas-tree candle;—but boiling hot wax and a No. 2 water color brush will answer. A small amount of movement of the nema during microscopic examination is very desirable because the various nemic organs reveal their contours more readily when sliding slightly one on another. Mounting direct into 5 per cent. KOH solution displays various cuticularized organs—mouth parts, spicula, etc., more distinctly.

(2) *Advantages.* There are many marine nemas obtainable at seaside stations more suitable for class use than *M. pristiurus,* but none of them is yet known to bear transportation so well. The drawbacks of *Metoncholaimus pristiurus* are: (1) Its amphids (very important characteristic organs, universal in nemas) though well developed, are rather difficult to see; (2) the sensory setae so prevalent on aquatic nemas are here not very well developed; (3) there are no eyespots; (4) the tissues are not quite as transparent, and hence not quite as readily studied, as in some other forms.

Its advantages are: (1) It is relatively large, and is available at any season; (2) it can be shipped long distances alive, and be kept alive for weeks in cool laboratory storage; (3) it presents the demanian system of organs—indicative of the fact that nemas possess whole systems of organs as yet comparatively unexplored; (4) it presents all the numerous advantages which well-developed free-living forms possess over the parasitic forms commonly used as teaching material, such as, among other things, (a) distinctly developed mouth parts, and salivary glands, (b) caudal glands and spinneret, (c) well-developed amphids, (d) sensory setae, (e) readily visible central nervous system, parts of the peripheral system being easily demonstrable by using sea water-methylene blue (over night), (f) a more or less visible renette, (g) well-developed longitudinal cords and associated organs, (h) visibly differentiated intestinal cells (among them the "birefringent" cells), (i) a double gonadic system in the male, *the primitive and normal condition* (although, here, as it happens, single in the female and thus atypical), (j) growth, fertilization, etc., of the living ova can be observed *in situ;*—all these more or less readily observable without dissection.

(3) *Shipping.* It is recommended that in transportation for laboratory use *M. pristiurus* be shipped with half a liter or so of sea water in a separate container, since additional pure sea water is necessary as a mounting medium for the living nema, and permits renewal during lengthy laboratory storage of the sea water containing the nemas; also, that it be put into the mail or express immediately before closing time, that it be packed with ice or solid insulated CO_2 so as to remain cool in transit, and that it be shipped under cool conditions. The nema is so small that hundreds can be packed in the small space suitable to air mail, and this method of shipping is very desirable, especially as air mail temperatures are not likely to be excessively warm. These nemas stand freezing temperatures.

N. A. COBB

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

SPECIAL ARTICLES

A CHART OF RADIOACTIVE ELEMENTS INDICATING THEIR STRUCTURE

THE terminology and some of the data of this chart are based upon the recent report of the International Radium-Standards Commission.[1] The purpose of the chart is to indicate the structure of the nucleus as well as that of the electron shell of all radioactive isotopes.

The lower part contains the familiar disintegration series: double circles for the uranium-radium family; single circles for the uranium-actinium family, and squares for the thorium family. The position of AcU and UY is doubtful and indicated by the broken circle. The average life of the atomic species is indicated by bold type—those having a period of over one year; Roman characters—those from one hour to one year, and italics—those existing less than one hour.

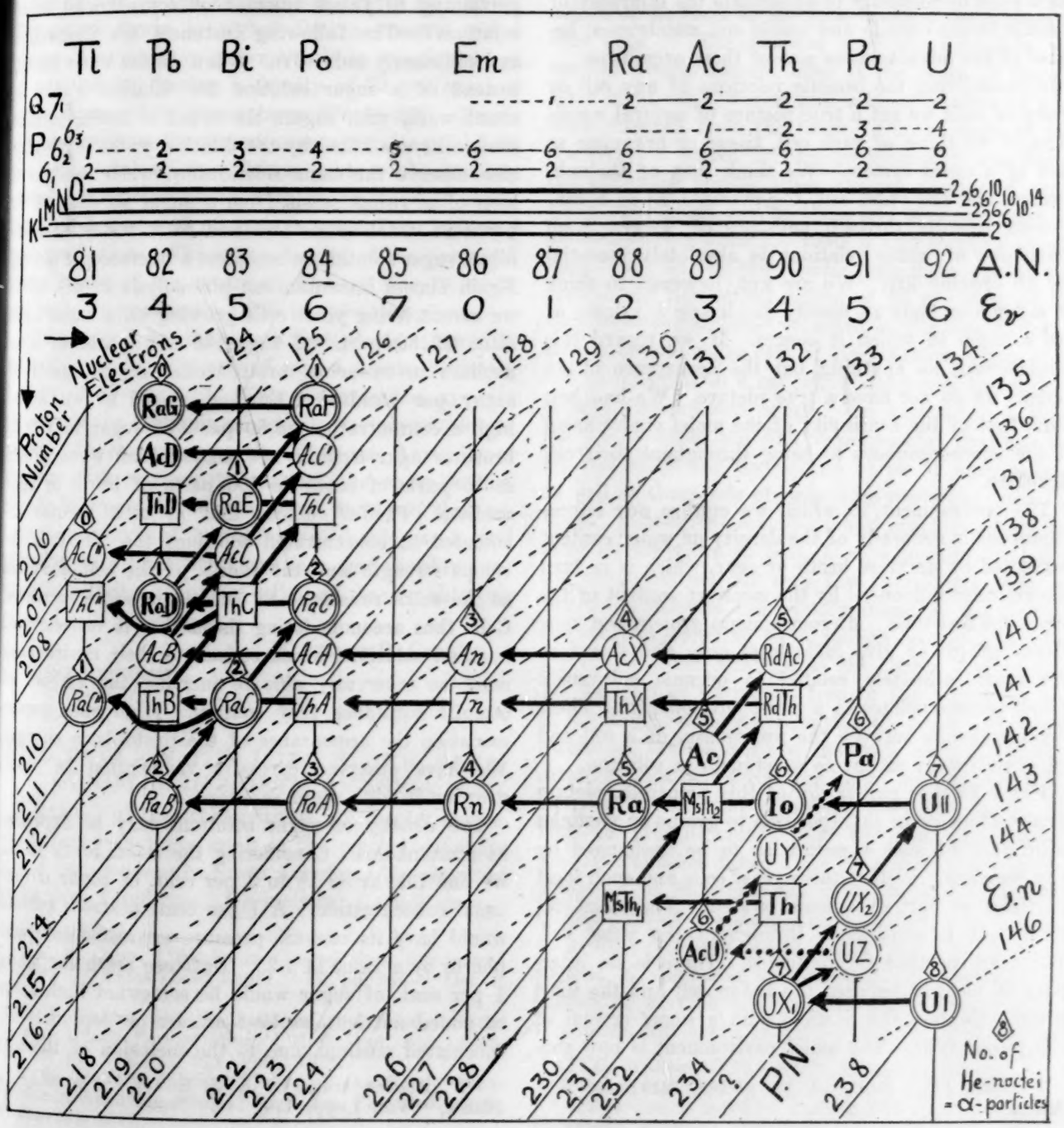
Nuclear structure is indicated by the number of

[1] Curie, Debierne, Eve, Geiger, Hahn, Lind, St. Meyer, Rutherford and Schweidler, *J. Am. Chem. Soc.,* vol. 53, p. 2437, July, 1931.

protons and electrons. The proton number, or isotopic weight, is shown on the left and lower edge, they occur in groups of three with some numbers missing. The number of nuclear electrons connects the isotopes at a different angle and it is interesting to note that there are in no instance more than three atomic species for a given number of nuclear electrons and each of these belongs to a different family. Thus 126 nuclear electrons occur in RaF, ThD, and AcC″, while 140 electrons are found in Pa, Io, $MsTh_1$. The table records all atomic species thus far known to exist between P.N. 206 and E_n 124 to P.N. 238 and E_n 146. The small number in the trapezium indicates the number of helium particles which the atomic species can lose. If $Pb^{206} = RaG = x$; $Pb^{207} = AcD = y$ and $Pb^{208} = ThD = z$; then it follows that $RaF = He \cdot x$; $AcC = He \cdot y$ and $ThC' = He \cdot z$ and $Rn = He_4 \cdot x$; $AcX = He_4 \cdot y$ and $ThX = He_4 \cdot z$ and so on to $Ul = He_8 \cdot x$. Alpha-rays are shown by the arrows pointing to the left, beta-rays by those pointing upwards.

The quantum numbers for the normal state are in the upper half of the table; the continuous lines indicate that the K, L, M, N, and O shells are filled, while the broken lines indicate the energy layers which are being filled up, that is the P and Q shells. The atomic number, A.N., and normal valence electrons, E_v, complete this portion of the chart.

A study of the chart reveals that in beta decay the nucleus not only loses an electron, but also the valence


Tl Pb Bi Po Em Ra Ac Th Pa U
Q 7
P 6₃ 6₂ 6₁
K L M N O
2 2 6 10 10 14
2 2 6
81 82 83 84 85 86 87 88 89 90 91 92 A.N.
3 4 5 6 7 0 1 2 3 4 5 6 Ev
Nuclear Electrons
Proton Number
124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 En 146
206 207 208 210 211 212 214 215 216 218 219 220 222 223 224 226 227 228 230 231 232 234 ? P.N. 238
RaG RaF AcD AcC′ ThD RaE ThC′ AcC″ AcC RaD ThC RaC′ AcB AcA An AcX RdAc RaC″ ThB RaC ThA Tn ThX RdTh Ac Pa RaB RaA Rn Ra MsTh₂ Io Ul
UY MsTh₁ Th UX₂ AcU UZ UX₁ Ul
No. of He-nuclei = α-particles

shell gains an electron, while in alpha decay, both nucleus and valence shell lose a pair of electrons each.[2]

INGO W. D. HACKH
COLLEGE OF PHYSICIANS AND SURGEONS,
SAN FRANCISCO, CALIFORNIA

THE SUGAR TOLERANCE OF YEASTS EXPRESSED IN ATMOSPHERES

MYCOLOGISTS who study microorganisms on culture media are presented with physiological problems, such as the osmotic relations of microorganisms to their substrata. The plant physiologist considers and observes such relations in single cells and in turn in groups of cells. The microbiologist studying yeasts has a good opportunity to appreciate the interplay of osmotic forces outside and inside cell membranes, because of the advantageous size of these organisms.

In considering the osmotic relations of any cell or group of cells we get a true picture of natural conditions, if we think of each cell, tissue or organism as part of a moist system. We think then of the substratum and the yeast cell, for example, as in a continuous relation through moisture or water. Such continuity of water relations is absolutely essential for all organic life. We are apt, however, to think of a fungous body as merely displacing a volume of the solution in which it occurs. If we regard this displacement as anything but the occurrence of an instant we do not have a true picture. We had best think first of the continuity of the moist environment of the microorganisms as being throughout their cell structure.

The environment in which we culture our microorganisms is generally of the density or water content presented by dextrose broth or agar, which is in turn theoretically influenced by the moisture content of the air in the test-tube. Microorganisms growing on agar slants absorb or give off solutes only and therefore are most intimately related to organic substances which became solutes in a moist environment. There is no exchange between the protoplasm of a cell and its environment except as substances in solution.

For a further realization of this principle, picture yeasts or molds in juxtaposition to grains or particles which are of such a nature as to be unchanged by any reaction. Picture these yeast cells and such inert particles as part of a moist system. The moist environment is continuous throughout the yeast cell. The inert particle is unaffected. There is no interplay of osmosis between the living cell and the inert grain. Replace the particle with a sugar crystal of the purest type. The moist environment is now continuous with the crystal as well as with the living cell. There can no longer be the inert relation which existed between the yeast cell and the inert particle. The living cell, the syrup films of the crystal and the crystal must adjust their osmotic relations, and this continually. Life is not an equilibrium, but is continually trying to approach it. It is always getting there. When we admit these conceptions, we must admit that all microorganisms which carry on metabolic and reproductive activities in concentrated solutions have a higher tolerance of high osmotic pressures than those subsisting only in dextrose broth of the standard methods or in the liquid phase of a solid culture medium.

What specific proofs are there of such a relation pertaining to yeasts tolerant of concentrated sugar solutions? The following instances are illustrative and sufficiently indicative. When we use water blanks instead of a sugar solution for dilution blanks in count work, with sugars the count is lower, because some cells are killed by the dilution water. We may also observe the same relationship when we take a loop of growing yeasts from a sugar solution of 50 per cent. total solids and add to it water or more dilute sugar solution to complete a microscopic mount. Again almost instantaneous plasmolysis occurs, when we mount living yeast cells growing on a sugar agar slant of 50 parts of sugar to 100 parts of agar medium in water or broth containing 35 parts of sugar per hundred. Further, yeasts grown at as high a concentration as 50 parts of sugar to 100 of broth or agar medium are smaller than when grown in 35 parts of sugar to 100 parts of broth or agar medium. Pfeffer[1] claims that as cells become acclimated to concentrated solutions the cell wall develops strength and the radius of the cell decreases as the cell's resistance to osmotic pressure increases. Cells thus accommodating themselves to concentrated nutrient solutions which constitute their environment must be inherently able to increase the amount of osmotic substance they contain. With such accommodation the appearance of the protoplasm changes. We have observed excessive vacuolation in yeasts growing in high sugar solutions.

The density of sugar solutions may be expressed as atmospheres. Considering the usual broth media, we find that from 1½ to 3 per cent. of sugar is their usual concentration. A 1 per cent. dextrose solution would have its osmotic pressure expressed in atmospheres by a value of 1.25. Dextrose broth containing 1 per cent. of sugar would be somewhat higher, due to added nutrient, as beef extract or peptone. The inoculated medium, due to the inclusion of the sam-

[2] Hackh, *Phys. Rev.*, vol. 13, p. 165, 1919; and *Phil. Mag.*, vol. 39, p. 155, 1920.

[1] W. Pfeffer, trans. by A. J. Ewart, "Physiology of Plants," Vol. I, pp. 136, 140. 1906.

ple, would be somewhat higher in value expressed as atmospheres. Plant cells when turgescent have a cell sap represented by 5 to 10 atmospheres. Beet sugar sap has a value of 15 to 21 atmospheres, or that of a 25 to 30 per cent. solution of sucrose. Fungi as Penicillia and Aspergilli have been grown in concentrated solutions having a value of 157 to 160 atmospheres, or an equivalent of 45 per cent. KNO_3.[2] Owen[3] in Louisiana was able to grow yeasts in molasses having a density of 70 per cent. total solids or when figured as sucrose the equivalent of 225 to 260 atmospheres. As molasses contains lower sugars and gums the figure is actually higher. We have grown yeasts in culture tubes where the medium was 62 per cent. total solids, which may be represented by 140 to 180 atmospheres figured as sucrose. The actual figure is higher for the reason stated above. Also we have grown yeasts in hanging drops of mixed syrup having a density of 70 per cent. or again expressed in atmospheres 225 to 260. Yeasts did not grow in the purest cane syrup (c.p.) of 68 per cent. total solids. Cream centers of chocolate coated candies inoculated with sugar tolerant yeasts burst after a period of storage normal for ripening such confections. The syrup density of the expressed syrup phase of the cream of fondant was 76 to 77 per cent., or greater than 225 to 260 atmospheres.

Summarizing, we may state that yeasts apparently do not grow in solutions of mixed sugars having a density of 79 per cent. This concentration appears to indicate the cessation of activity for sugar tolerant yeasts. Investigators at the Michigan Agricultural Station have apparently reached the same conclusion.[4] We need to bear in mind, however, that between cessation of reproductive development and cessation of all activity there is a period where enzymatic activity of living cells and finally autolysis of dead cells progresses.

MARGARET B. CHURCH

URBANA UNIVERSITY,
URBANA, OHIO
August, 1931

MORE DATA ON THE LUNG FLUKE, PARAGONIMUS, IN NORTH AMERICA

WALLACE,[1] of the University of Minnesota, has recently found that the mink is the normal definitive host of *Paragonimus* in North America. He examined minks from fur farms. He included a small amount of life history data in his report and in a second article[2] gave a more detailed account of this phase of the work. The work here reported was begun in March, 1930, independently of and without knowledge of Wallace's work. My records show that metacercariae were discovered June 22, 1930, and mature worms secured on September 4, 1930, from an experimentally fed cat. The mink was determined to be the normal definitive host in North America without knowledge of Wallace's contribution which was published after my survey of the fur-bearing animals was completed.

In the fall of 1929, in connection with another problem, a cat was used that had come from Platt, a small village on the outskirts of Ann Arbor. Examination of its feces at the time revealed the characteristic eggs of *Paragonimus* and this diagnosis was verified several months later at the death of the cat when eight adult worms and a large number of eggs were removed from the lungs. On the basis of this discovery, a search for the metacercaria was begun the following spring when various species of crayfishes from local ponds, lakes and streams were examined and on June 22, 1930, a metacercaria closely resembling that of the Asiatic lung fluke was discovered in the pericardial region of 60 per cent. of the *Cambarus propinquus*[3] collected in Fleming Creek, a stream several miles east of Ann Arbor. Cysts were fed at intervals to a cat which developed the characteristic *Paragonimus* cough. On September 4, 1930, ten weeks after the first experimental feeding, the cat was killed and forty-three worms of various ages as well as thousands of eggs were recovered from the lungs. Subsequent examination of crayfishes from the same stream revealed that *C. robustus* also harbored the metacercariae but very few individuals were infected. The cysts are usually found in the wall of the heart or adhering to it, though occasionally some are found either attached to the tissues surrounding the pericardial cavity or free in the lumen of any of the large blood vessels leaving the heart. In heavy infections, the majority of the cysts occur in clusters arranged in a belt across the broad base of the heart. Even in the heaviest infections, the cysts are absent from the gills or muscles. In the fall, collections of stream crayfishes taken from all parts of the lower peninsula to determine the distribution of the worm in this part of the state, added another host species, *C. virilis*. Wallace found metacercariae in a single species, *C. immunis spinirostris*. Apparently any species of crayfish occurring in the appropriate environment will serve as an intermediate host though

[2] *Ibid.*, p. 140.

[3] Wm. L. Owen, "Swells in Canned Cane Syrup and Molasses," "Facts about Sugar," 21, pp. 946–9, Oct. 2, 1926.

[4] F. W. Fabian and R. I. Quinet, "A Study of the Cause of Honey Fermentation," Mich. Agr. Sta., *Tech. Bull.* 92, pp. 1–41, 20 figs, Feb., 1928.

[1] F. G. Wallace, "Lung Flukes of the Genus Paragonimus in American Mink," *Jour. Am. Vet. Med. Asso.*, 31: 225–234, 1931.

[2] F. G. Wallace, "The North American Lung Fluke," SCIENCE, n. s., 73: 481–482, 1931.

[3] The writer is indebted to Mr. E. P. Creaser, of the University Museums, for identification of crayfishes.

some species prove to be more capable hosts than others.

To determine the distribution of the lung fluke and its normal host in Michigan, there were secured from trappers all over the state, during the 1930 trapping season, 1,011 carcasses of fur-bearing animals consisting of 563 minks, 308 raccoons, 109 opossums, 22 weasels, 8 muskrats and one badger. The flukes were found only in minks of which 17 per cent. carried the infection. Though raccoons are voracious eaters of crayfishes they are apparently immune to lung fluke infection. A raccoon which had been fed hundreds of cysts, during the summer of 1930, was found to be negative upon examination in the fall. An attempt is now being made to infect young raccoons. An unsuccessful attempt was made to infect an opossum following the examination of the carcasses. No sign of infection was found in 241 carcasses of wild muskrats examined in connection with a former problem though a feeding experiment demonstrated that muskrats are capable of infection. The 8 muskrats reported above were examined because they had been caught in Honey Creek, a stream in which all the *C. propinquus* examined, as well as a high percentage of the *C. robustus,* were infected. *C. propinquus* from this stream not uncommonly yield 40 metacercariae while one yielded 75.

Paragonimus occurs rarely in cats or dogs. Though thousands of cats and hundreds of dogs are examined annually in laboratories, this obvious pulmonary infection is seldom reported. The rarity of the infection in these animals is explainable on the basis of their food habits. It is generally believed that the various mammalian hosts of *Paragonimus* obtain their infection through the eating of fresh-water crabs or crayfishes but to my knowledge it has never been proven that cats or dogs eat these crustaceans. On two occasions both living and dead crayfishes were placed before the naturally infected cat from Platt following several days of starvation but she did not display the slightest interest in them. This same cat at various times eagerly ate the flesh of wild mammals and birds, even hawks and owls, though cooked food was in the cage. Another cat manifesting the same attitude toward wild food could not be induced to eat crayfishes after two days of starvation.[4] This experiment has not yet been tried upon dogs. If cats and dogs do not eat crayfishes, the only other possibility of their securing *Paragonimus* is by eating the final hosts containing recently ingested metacercariae or slightly developed worms, thus acquiring their infection secondarily. That this method of transmission is possible, at least with worms not exceeding twenty-four hours' sojourn in the final host, was demonstrated when two rats fed one hundred metacercariae twenty-four hours previously were forcibly fed to a dog. On examination two months later, four young adult worms were found in two cysts in the dog's lungs.

Though it is the consensus of opinion that nothing will eat a mink, data have been collected to prove that both cats and dogs do occasionally eat them. Accounts of personal experiences on this matter were solicited from trappers of minks. Out of thirty-three replies, three trappers stated that they had seen dogs eat minks. One trapper reported that he had seen cats eat minks while still another replied that cats do eat minks but he did not indicate that he had witnessed the act. Two other trappers volunteered the information that they had seen foxes eat minks.

When the collection of carcasses of fur-bearing animals mentioned above was being made, the fresh carcasses of minks were given to each of four cats. Two of the cats would not touch the carcasses while one ate the liver, lungs and muscles when they were removed from the carcass and given to it separately. The fourth cat, an exceptionally large animal, at the regular feeding time ate the entire thorax of a mink and might have eaten more had not the remainder been removed.

Further studies on the various aspects of the *Paragonimus* problem are under way and will be reported upon from time to time.

DONALD J. AMEEL

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF MICHIGAN

[4] Since this manuscript was submitted two of my cats, when starved, have eaten crayfishes.

BOOKS RECEIVED

BROOKS, F. T. and T. F. CHIPP, Editors. *Report of Proceedings of the Fifth International Botanical Congress, Cambridge, 1930.* Pp. xiv + 680. Illustrated. Cambridge University Press. $7.00.

CARTER, W. T. *The Soils of Texas.* Bulletin No. 431. Pp. 189. Agricultural and Mechanical College of Texas.

CHAPMAN, ROYAL N. *Animal Ecology.* Pp. x + 464. McGraw-Hill. $4.00.

DINWIDDIE, COURTNAY. *Child Health and the Community.* Pp. vii + 80. Illustrated. Commonwealth Fund. $1.00.

HALL, SIR A. D. *The Soil.* Fourth edition. Pp. xvii + 388. Illustrated. Dutton. $3.00.

LENZEN, VICTOR F. *The Nature of Physical Theory.* Pp. xii + 301. Wiley. $3.50.

PISTON, DONALD S. *Meteorology.* Pp. viii + 187. 81 figures. Blakiston. $2.50.

SKRIFTER OM SVALBARD OG ISHAVET: D. SOKOLOV and W. BODYLEVSKY: *Jura- und Kreidefaunen von Spitzbergen.* Pp. 149. Illustrated. GUSTAV SMEDAL: *Acquisition of Sovereignty over Polar Areas.* Pp. 143. B. LYNGE: *Lichens Collected on the Norwegian Scientific Expedition to Franz Josef Land, 1930.* Pp. 31. Illustrated. Jacob Dybwad, Oslo.

WOOD, CASEY A., Editor. *Introduction to the Literature of Vertebrate Zoology.* Pp. xix + 643. Illustrated. Oxford University Press. $15.00.